Mollusks

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PLATES

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BY

Mrs. N. F. McMILLAN *and*
C. R. C. PAUL, M.A., PH.D.

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Overseas members are reminded that all monies due to the Society are payable in sterling.

J. Conch. **28**: 1–3 (1973)

TWO HISTORICAL '*PINNA INGENS* PENNANT' IN THE ROYAL SCOTTISH MUSEUM

David Heppell
The Royal Scottish Museum, Chambers Street, Edinburgh EH1 1JF

(*Read before the Society, 18 November 1972*)

1. TRAILL'S ORKNEY *PINNA*

Thomas Stewart Traill gave an acount of the zoology of Orkney in his article on "Orkney Islands" in Brewster's *Edinburgh Encyclopaedia* (Traill, 1830: 10–11) and included among the shells *Pinna ingens* Pennant, a name given to large, non-spinous specimens of *Atrina fragilis* (Pennant) [Latin *ingens* = very large]. This record received special mention from Rendall (1953) when he commented on Traill's list of Orkney Mollusca, as this was the only Orcadian *A. fragilis* known to Rendall until another specimen was taken in Scapa Flow in 1951. In fact, three other specimens had been trawled from Orkney waters in 1937 (detailed by Rendall (1956: 201) in a note added to his check-list of Orkney Mollusca) and in 1956 a particularly fine specimen, taken alive by seine net from 75–90 fathoms off the island of Westray, was obtained by Rendall for his own collection, now in Stromness Museum. Only one further specimen of *A. fragilis* from the Orkney area is known to the author: on 5 December 1968 "a good double valve, though broken at posterior by dredge" was taken from 16 fathoms in Scapa Flow, on a sandy bottom among *Chlamys opercularis* (L.)—*fide* Mr. Alan Skene. [But see note on p. 3.]

Rendall (1953) believed Traill's record to be authentic because the genus was unlikely to be confused with any other and because Traill's statement: "dredged from the depth of thirty to forty fathoms" indicated deliberate collection. Rendall was not aware, however, that the original specimen was still in existence. In 1959 a substantial part of the shell collections of the Bell-Pettigrew Museum of the University of St. Andrews was presented to the Royal Scottish Museum. Among this material was a specimen of *Atrina fragilis* labelled simply "*Pinna* Orkney" (Pl. I, Figs 1–2). From the apparent age of the label it seemed likely that here was the original specimen recorded by Traill. Comparison of the label with a sample of handwriting in a letter from Traill to Robert Jamieson, now in the Pollock-Morris MSS.*, confirmed this opinion. The specimen measures 22·5 cm. × 11 cm. It has warped somewhat and is in a fragile condition; the left

* Robert Jamieson (1774–1854) was Professor of Natural History in the University of Edinburgh from 1804 to 1854. He founded the Wernerian Natural History Society of Edinburgh in 1808. The Jamieson papers in private hands were preserved by his great-grand-niece Mrs. Jane Catherine Pollok-Morris (Sweet, 1969).

valve has split into two pieces. The specimen was probably not live-collected as specimens of the polychaete worm *Pomatoceros triqueter* (L.) adhere to the inside of the broken valve.

2. LASKEY'S *PINNA INGENS*

Also among the material received by the Royal Scottish Museum from St. Andrew's University is a specimen of *Atrina fragilis* labelled as follows: "*Pinna Ingens*. Recd. from G. Montague Esqr. Author Test. Brit. found in Salcombe Bay Devonshire 18 March 1806". The specimen measures 26 cm. × 14·5 cm. and is in fairly good condition, although parts of both valves have broken away at the posterior end. It seemed the shell could have belonged to any one of a number of conchologists who were in correspondence with Montagu, one possibility being Captain James Laskey of Dunbar.

It is known that Laskey had formerly resided in Devonshire as Donovan (1803) mentions some shells communicated to him by J. Laskey, Esq., of Crediton, and his friendship with Montagu may have dated from that time. About 1804 Laskey moved to Dunbar, East Lothian, where he collected most of his additions to the British fauna, many of which proved to be exotic shells probably derived from ships' ballast (Forbes and Hanley, 1848: 345). He contributed a "Catalogue of the shells of North Britain" to the supplementary volume of Montagu's *Testacea Britannica* (Montagu, 1808: 172–177) and later (Laskey, 1811*a*) published an "Elucidation respecting the *Pinna ingens* of Pennant's 'British Zoology' ", in which he stated he had "received specimens from my friend Mr. Montagu of his *Pinna ingens* of the Western Coast".

Laskey was one of the original members of the Wernerian Natural History Society of Edinburgh, to which he gave a collection of British shells "as far as duplicates are in my cabinet" (Laskey, 1811*b*: 370). A manuscript "*Catalogus, Vermium, Radiatorum, Moluscorum et Zoophytorum quae in Museo Societatis Werneriensis asservantur*", compiled by Thomas Brown and now in the Royal Scottish Museum, reveals that most of the shells in the Society's cabinet had been received from Laskey. The entry under *Pinna* indicates that one valve of a *Pinna ingens* was in the collection, presented by Laskey and Jamieson, but without locality. On the dissolution of the Wernerian Society in 1858 this collection passed to the Museum of the University of Edinburgh (Sweet, 1967) and subsequently to the Royal Scottish Museum, but no shell positively attributable to Laskey has so far been traced from this source.

Comparison of the label on the shell sent by Montagu (Pl. I, Fig. 3) with a sample of Laskey's handwriting in a letter to Jamieson, now in the Pollok-Morris MSS., again confirms the identity of the scripts. Consequently the specimen now in the Royal Scottish Museum must be one of the specimens used by Laskey in his "elucidation" of Pennant's species. As it is not listed in Brown's catalogue this shell would seem to have been kept by Laskey for his own collection, but in 1813, or soon after, Laskey "mysteriously disappeared from Dunbar, leaving a wife and child and all his shells and curiosities behind him. Nothing was heard of

him for nearly twenty years, when about the year 1832, his wife, while walking on the beach with her brother, was astonished, on coming up to a person intently scrutinizing the shingle, to find her long-lost husband at his old employment of shell collecting. A few days afterwards, however, he disappeared as mysteriously as he had come, and after a lapse of some years his deserted wife heard of his death in indigent circumstances" (Gray, 1879). Some time after this, Laskey's collection was evidently divided and sold, as Forbes and Hanley (1851 : 526) mention that Forbes bought a specimen of *Voluta heteroclita* Montagu at the sale of Laskey's collection. The *Pinna ingens* was presumably purchased at the same sale, but it is not known through whose hands it passed before reaching the Bell-Pettigrew Museum.

ACKNOWLEDGMENTS

I should like to thank Mrs. Stella M. Turk for bringing the most recent Orkney record of *Atrina fragilis* to my attention and Miss Jessie M. Sweet for educing the letters of Traill and Laskey in the Pollok-Morris MSS.

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Note added in proof:

Mrs. S. M. Turk has since notified me of a further record of *A. fragilis* from Orkney waters, submitted to her by Mr. David McKay: 58°55′ N, 2°50′ W. 100 m. 29.iv.1969.

REVIEW

Marine Shells of the Pacific—Vol. II. By Walter O. Cernohorsky, pp. 411, 4 col. plates, 64 black-and-white full-page plates (covering approx. 600 spp.), 28 text-figs. Pacific Publications (Aust.) Pty., Technipress House, Albert Street, Sydney, N.S.W., 1972. Price $13 (Australian).

Some years ago I bought a copy of "Marine Shells of the Pacific" by Walter Cernohorsky, published in 1967. As a keen collector of tropical shells I found it most useful. It had, however, one serious fault—it covered such a small number of genera, and often since then I have wished for an enlarged second edition to help with my problems of classifying Indo-Pacific marine molluscs.

A review of Cernohorsky's "Marine Shells of the Pacific, Volume II", published by Pacific Publications (Aust.) Pty. Ltd., Sydney, inevitably therefore starts with a considerable bias in its favour. However, even if this were not so, I should still write highly of this excellent book.

The descriptions of the shells are good, as also are the photographs, four of the plates being in colour. It is always helpful to have the illustration on the same page as, or facing, the description, but this gives rise to many problems and the next best answer, as in this publication, is to have all the plates together at the back of the book.

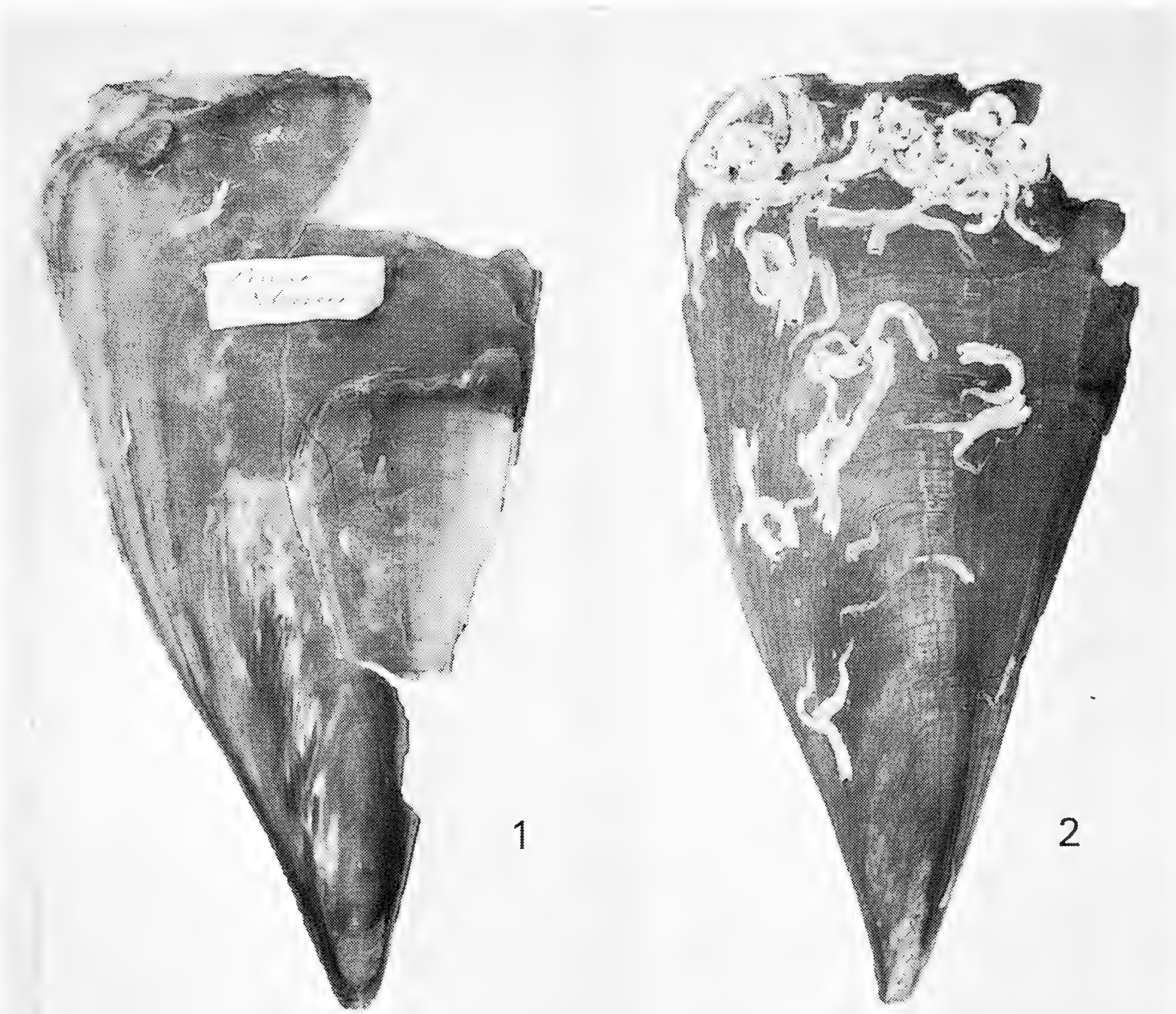
The first 25 pages are devoted to "Shell Collecting in the Pacific", giving helpful general notes and advice; "Marine Animals Harmful to Humans" also gives useful advice on what dangers to avoid; "Habitat and Zonation" and "The Divisions of Mollusca". There follows 7 pages on Molluscan Classification, giving Classes, Subclasses, Orders, Suborders, Superfamilies and Families. The text which follows gives the genera and some 600 species. A drawing of a typical gastropod shell illustrates the terminology of its parts. 208 pages of text are followed by 68 plates of photographs.

The Appendices cover 8 pages in "General References' giving authors 'dates and titles of relevant publications, 4 pages of a glossary, and a table of measures, English/Metric and Old Measures.

There is a full index of 17 pages and last, but by no means least, the publishers have been sensible enough to give a double-page spread inside both front and back covers to a map of the Pacific and Eastern Indian Oceans. These could have carried more detail—but are still very helpful. Many a book has lost a great deal for want of a map or maps.

For an enthusiastic collector of shells from the Pacific I suggest this book is a must. At $13 (Australian) it's cheap at the price. I only wish I could buy similar books on the Indian and Atlantic Oceans, and the Mediterranean and Caribbean Seas.

I say with all sincerity "Thank you, Cernohorsky". A. P. H. Oliver



Historical specimens of *Pinna ingens* Pennant

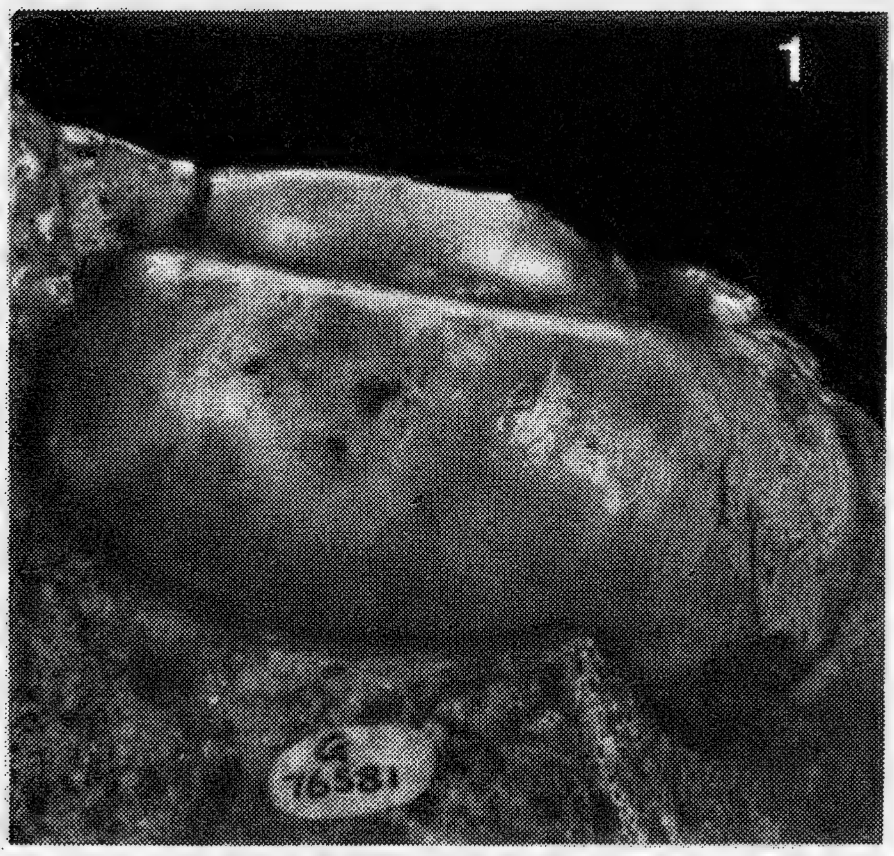
Fig. 1. Traill's specimen of "*Pinna ingens* Pennant" from Orkney. Interior of left valve, showing original label. RSM 1959.52.1.

Fig. 2. Traill's specimen. Exterior of right valve.

Fig. 3. Laskey's specimen received from Montagu. Salcombe Bay, Devonshire, March 1806. Exterior of left valve, showing original label. RSM 1959.52.2.

PHOTOGRAPHS BY R. C. THOMSON, ROYAL SCOTTISH MUSEUM

PLATE II



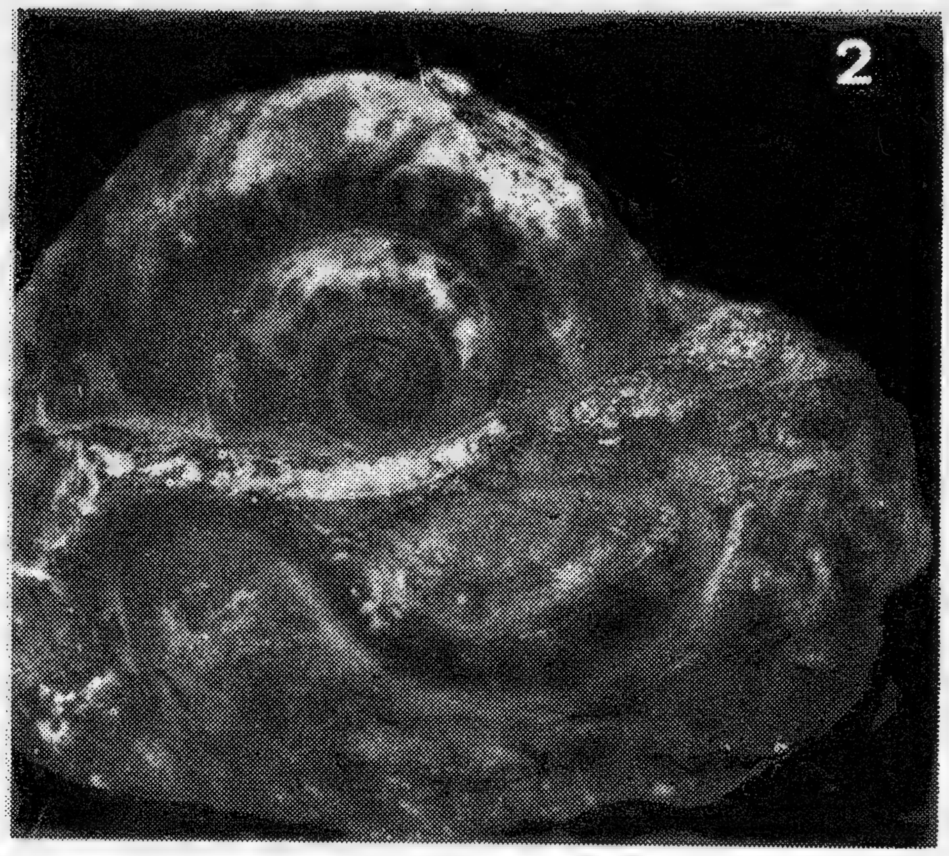


Fig. 1. *Lanistes grabhami* Cox 1933, side view of large specimen; Hanakat el Kuleiwat (Sudan); B.M (Nat. Hist.) G76581: approximately × 1·1.

Fig. 2. idem. apical view small, fragmented specimen, Hanakat el Kuleiwat (Sudan); B.M. (Nat. Hist.) G76585: approximately × 2·1.

J. Conch. **28**: 5–8 (1973)

A NOTE ON THE HUDI CHERT FRESHWATER MOLLUSCS WITH DESCRIPTION OF *LANISTES GRABHAMI* COX 1933 FROM HANAKAT EL KULEIWAT (SUDAN)

Achilles Gautier
Laboratorium voor Paleontologie, Rozier, 44, B 9000 Gent, Belgium

(Read before the Society, 21 October 1972)

From the Sudan Tertiary, freshwater molluscs have been described from two localities only: Hudi and West of Zeidab (Cox, 1933). At both sites deposits of the Hudi Chert Formation are found. This formation is considered as Lower Tertiary and overlies uncomformably the Nubian Sandstone Formation of Mesozoic age. According to Whiteman (1971) the dating by Cox (ibidem) of the Hudi Chert Formation as Upper Eocene or Lower Oligocene is not acceptable, for it is based on the presence of poorly preserved ampullarids, which have been identified as conspecific with forms (*Pseudoceratodes mammuth, Ps. irregularis*) already known from Egypt but not in stratigraphic context. In certain areas the Hudi Chert Formation consists of silicified lake deposits, some of which appear to have been laid down on lake margins. In others it represents comparable silcretes not necessarily related to former lake deposits, and because of this is now thought to be polygenetic (Whiteman, ibidem). Moreover erosion and transport have spread Hudi Chert material and add to the difficulty of identifying original outcrops.

A list and a map of Hudi Chert localities can be found in Whiteman (ibidem, p. 93, Table 10). The locality Hudi from which an extensive collection of molluscs was described, corresponds to Hudi Station. "West of Zeidab" is not listed, but it is said in the text that the material was found some 13 km. south of Atbara on the west bank of the Nile. At Hudi Station the deposits are lacustrine, as is also indicated by the rich fauna. The nature of the outcrop west of Zeidab is unknown to me. This locality yielded only *Pseudoceratodes rex*, and a doubtful *Pinna* sp., which may indicate marine influence.

As can be seen in the list given below, the Hudi Station fauna is dominated by ampullarids. These indicate a marshy environment if we accept that the ecological requirements of the group have not changed in the course of time (principle of actualism). Probably this assumption is correct, as indicated by certain geological observations (lake margin deposits!) and the fact that *Lanistes grabhami* is a form clearly related to the extant *L. carinatus*. This species or a closely related form is already known from the so-called "Miocene" deposits of East Africa (Verdcourt,

1968); Van Damme and Gautier, 1972) and Lake Albert (Gautier, 1965). The presence of *Achatina hudiensis*, a landsnail, also points to conditions transitional between shallow water and subaerial environment (cf. paleoecology of Muruarot Van Damme and Gautier, *ibidem*).

In the light of the principle of actualism, another problem concerning the Hudi Chert arises. Today in most African regions ampullarids are represented by only one species of the extant taxa in their preferred environments. Hence the presence of six ampullarid species in the Hudi Chert Formation, all collected at one site (Hudi Station) strikes one as odd (see also the frequencies of the *Pseudoceratodes* spp.). Therefore the original material has been re-examined.

Unfortunately the preservation of several ampullarids from Hudi as well as from other deposits is often very poor, neither do we know sufficient concerning the morphological variability of the planorbid forms ascribed to *Pseudoceratodes*. Hence to avoid further complication of the nomenclature no emendations are proposed, except that *Pila* sp. Cox, 1933 should be included in *Pila colchesteri* Cox, 1933. I would like, however, to warn against the procedure of naming specifically isolated and very poorly preserved samples as is still done (e.g. Abbass, 1962). This only adds to the existing confusion.

In spite of the author's efforts, the list of the Hudi Station fauna still includes 5 ampullarid species:

Species	*Frequency*
Pila colchesteri Cox, 1933 (includes *Pila* sp. Cox, 1933)	frequent
Pseudoceratodes mammuth (Blanckenhorn, 1900)	rare
Pseudoceratodes irregularis (Blanckenhorn, 1900)	rare
Pseudoceratodes rex Cox, 1933 (holotype from West of Zeidab)	frequent
Lanistes grabhami Cox, 1933	frequent
Hydrobia sudanensis Cox, 1933	rare
Achatina (*Burtoa*?) *hudiensis* Cox, 1933	rare
Stenogyrinae, gen. et sp. indet. (could be a freshwater shell)	rare
Planorbis berberensis Cox, 1935 (new name for *P. siliceus* Cox, 1933, *non* Eichwald 1835, *non* Brown and Pilsbry, 1914)	rare
Planorbis nubianus Cox, 1933	rare
Pinna sp. ? (West of Zeidab)	rare

Only *Lanistes grabhami* is redescribed here. It includes the material formerly collected at Hudi Station and a collection made at Hanakat el Kuleiwat (lat. 17°52′, long. 31°19′) by Mr. R. C. Wakefield and presented to the British Museum (Natural History) in December 1939. Hanakat el Kuleiwat is listed in Whiteman (ibidem), but the presence of fossils is not mentioned.

Lanistes grabhami Cox, 1933

Lanistes grabhami Cox, 1933, pp. 335–339, Pl. III, Figs. 4a, 4b and 6

Material

Hudi: the type material (G54985)*; one specimen not mentioned or catalogued in Cox (1933) and labelled *Lanistes* ? (G55001).

Hanakat el Kuleiwat: one rather large specimen partly buried in matrix (G76582); two comparable specimens, one of which is only visible as an irregular section through the shell (G76581) (Fig. 1); an incomplete internal mould of a medium-sized specimen, the remaining test has been replaced by granular silica blurring to a certain extent the morphology of the internal cast which was made in plasticine (G76586); one somewhat doubtful juvenile in matrix (G76585); one large much eroded specimen with adhering matrix (G76583); one rather complete specimen with very well preserved growthlines and adhering matrix, shell broken transversally and the two halves separated by a wedge of matrix and displaced with respect to each other along the plane of fragmentation (G76584) (Fig. 2).

Measurements

	H	D
G76581	±35 mm.	±53 mm.
	—	37,5
G76582	—	±50
G76584	±14	±25
G76586	±14	±25

Remarks

Hudi material: The specimen G55001 is large but very incomplete. The basal angulation however is well visible and marked. For reasons of comparative ecology (see above) and the fact that the specimen as far as reconstructable agrees with the form described specifically, I think it can be included in *L. grabhami*.

Hanakat el Kuleiwat material: None of the specimens is complete. However the combined observations on the material yield a description which corresponds and supplements the original one: sinistrally coiled shell with whorls increasing markedly less than in the recent *Lanistes carinatus*; rounded peripheral angulation, upper whorl periphery also somewhat angular; umbilicus open and deep, bound by a marked basal angulation; growthlines comparable with those in recent *Lanistes*; thickened bundles of growthlines corresponding apparently to former apertures.

Remarks: The morphological differences between the recent *L. carinatus*, *L. antiquus* (Upper Eocene, Egypt) and *L. grabhami* have already been evaluated by Cox (1933). *L. antiquus* and *L. carinatus* are very closely related morphologically. Possibly they are also genetically related. *L. grabhami* then represents a different evolutionary line or a temporary offshoot of which today no descendants exist. In view of the uncertainty concerning the age of the Hudi Chert Formation however, the possibility exists that *L. grabhami* antedates *L. antiquus*, as a more

* The number corresponds to the catalogue numbers of the B.M. (Nat. Hist.).

primitive predecessor. It should be mentioned in this connection that Jodot (1953, p. 84) ascribes *Pseudoceratodes rex* to the Ypresian (Early Eocene). It would represent an early stage in the development of this genus.

CONCLUSION AND SUMMARY

The Hudi Chert Formation at Hanakat el Kuleiwat yielded a monotypical assemblage of the ampullarid *Lanistes grabhami*. The Hudi Station collection is also dominated by ampullarids. Both samples indicate very probably marshy conditions on lake fringes. However the number of specifically different forms is probably too high, but poor preservation and lack of knowledge of the variability especially of *Pseudoceratodes* make it impossible to propose valuable emendations. Possibly *Pseudoceratodes rex* and *Lanistes grabhami* can be assigned to the Early Tertiary (Lower Eocene ?) as they appear to represent primitive members of their respective genera. Hence the lake deposits of the Hudi Chert Formation may be of that age.

ACKNOWLEDGMENT

I thank the Trustees of the British Museum (Natural History) for the loan of the collection from Hudi, West of Zeidab and Hanakat el Kuleiwat.

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Conch. 28: 9–10 (1973)

THE NAMES *PARTULIDA* SCHAUFUSS, 1869, AND *SPIRALINELLA* CHASTER, 1901 (GASTROPODA: PYRAMIDELLACEA)

James X. Corgan
Austin Peay State University Clarksville, Tennessee, U.S.A.

(*Read before the Society, 21 October 1972*)

In standard molluscan nomenclators, the name *Partulida* Schaufuss, 1869, is often listed among the valid and useful genus-group names for pyramidellacean gastropods of the odostomiid stock (e.g. Winckworth, 1932). *Turbo spiralis* Montagu, 1803, is cited as the type species and *Spiralina* Chaster, 1898, and *Spiralinella* Chaster, 1901, are generally listed as objective synonyms. In the world fauna, the name *Spiralinella* Chaster, 1901, is still, at least occasionally, used (e.g. Saurin, 1961, p. 242). This paper contends that usage of *Spiralinella* Chaster, 1901, is proper.

The generic name *Partulida* Schaufuss was introduced in a listing of molluscan genera. The one hundred and twenty-seventh name in the list was "*Odostomia* Flemg" and under this *Parthenia* Lowe appeared as a subgenus. The one hundred and thirty-fifth name was *Partulida* Schaufuss and *Parthenia* Adams was listed as a synonym (Schaufuss, 1869, p. 6). No other information is provided but the intent of Schaufuss is clear. There is no *Parthenia* Adams. Schaufuss distinguished between *Parthenia* Lowe and *Parthenia* Lowe in the sense of Adams. He ranked *Parthenia* Lowe in the sense of Adams as a genus and regarded it as a genus without a name. For the nameless taxon he offered a new name, *Partulida* Schaufuss.

To make the name *Partulida* nomenclaturally meaningful it is necessary to identify the original content of the genus and then to select a type species. The original content of *Partulida* is composed of those species referred to *Parthenia* Lowe, 1841, by Adams prior to the establishment of *Partulida* by Schaufuss in 1869. Unfortunately, Schaufuss did not identify Adams by initial, date or in any other way.

It is relatively simple to trace *Parthenia* Lowe through the primary zoological literature from 1841 to 1869 and to catalogue the usage of *Parthenia* by people named Adams. Several people named Adams were active students of small molluscs. They published many papers involving *Parthenia* and Schaufuss was familiar with the literature of the period. The original content of *Partulida* can not be identified and a type can not be selected. Thus, the name *Partulida* Schaufuss, 1869, is a *nomen dubium*.

Prior to a study by Iredale (1917), *Partulida* Schaufuss had been an unused

name. Since that time it has been occasionally used in the Western European fauna for a genus that has *Turbo spiralis* Montagu, 1803, as its type species. *Turbo spiralis* is also the type species by monotypy of *Spiralinella* Chaster (1901, p. 8), a replacement name for *Spiralina* Chaster, 1898, *non* Hartmann, 1840. In the world fauna, *Spiralinella* Chaster seems to be used at least as frequently as *Partulida* Schaufuss.

CONCLUSIONS

Spiralinella Chaster, 1901, is the only name that should be used for a genus that has *Turbo spiralis* Montagu, 1803, as its type species. The name *Partulida* Schaufuss, 1869, is a *nomen dubium* because a type species can not be designated.

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J. Conch. **28**: 11–12 (1973)

LAURIA CYLINDRACEA AND *GRANOPUPA GRANUM*, TWO SPECIES OF TERRESTRIAL MOLLUSCS TO BE REMOVED FROM THE SOUTH AFRICAN LIST

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(*Read before the Society, 21 October 1972*)

In 1963 Verdcourt introduced the pulmonate gastropod land snails *Lauria cylindracea* (Da Costa, 1778) and *Granopupa granum* (Draparnaud, 1801) to the South African list on the strength of material in the British Museum (Natural History), London (Verdcourt, 1963, pp. 406, 407). These specimens were obtained by or through Prof. E. Hutchinson at "Aleudia" in the Transvaal, South Africa. Initially the South African record for *Lauria cylindracea* did not give rise to much doubt because the genus is known to occur with some five species in the Cape Province, one of which indeed occurs as far north as the Transvaal (Connolly, 1939, pp. 399–402; cf. also Zilch, 1959, p. 171). *Granopupa granum*, however, was considered by Verdcourt to be an introduced species in South Africa.

In June 1972, I was able to check on the specimens in the Natural History Museum. A scrutiny of the material of both species left no doubt as to correct identification.

A search through the catalogue of the Mollusca Section of the Museum, however, resulted in quite a different picture. Under nos. 1956.4.24.2-199 there has been entered a series of land molluscs from Prof. E. Hutchinson and all localized as from "Aleudia", Transvaal, South Africa. The last column of the catalogue shows the year 1924, presumably the year of the material having been collected and/or presented to the Museum. The material has been entered under the then used generic names of *Helicella*, *Otala*, *Hygromia*, *Rumina*, *Pyramidula*, *Tudorella*, *Pupilla*, *Ferrussacia*, *Helicodonta*, *Clausilia*, *Hyalinia* and *Euparypha*. No relevant correspondence could be found, notwithstanding the kind efforts of the staff of the Mollusca Section.

A glance at the genera and species in the catalogue reveals that virtually none of these is normally known from South Africa and that obviously all material under discussion is wrongly localized. The general assemblage of species is what can be expected to have been obtained somewhere along the western coasts of the Mediterranean, such as in southern France, northwestern Italy, etc. Geographical names that resemble "Aleudia" abound in those regions.

It is a well-known fact that a proportion of museum material is usually accom-

panied by wrong locality labels (cf., e.g., Schilder, 1956, pp. 12, 99, etc.). There is generally no need to draw attention to such samples, were it not that the above two species had crept into print which necessitates their being expunged from the South African list.

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DISCUS ROTUNDATUS (MÜLLER) GROWING ON ALGAE

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(*Read before the Society, 18 March 1972*)

INTRODUCTION

Taylor (1909) states that little is known of the food preferred by *Discus rotundatus* (= *Pyramidula rotundata*) apart from the work of Gain (1891) who found that it would eat certain fungi, wild plants and garden vegetables. From the examination of faeces Frömming (1954) showed that *D. rotundatus* ingests humus, plant hairs, xylem vessels, pollen, fungus spores, sand, oxalate druses, nematodes, algae, large fungi, nettles and paper. In the course of work currently in progress on the life cycle and feeding of *D. rotundatus* it has been possible to confirm that this snail feeds on algae and to show that immature specimens are able to grow on it. This paper is concerned with the feeding and rate of growth of *D. rotundatus* on algae.

HABITAT

The snails were collected from an old quarry situated beside the A3 road where it crosses Portsdown Hill (National grid reference 41/666064) on the northern fringe of Portsmouth (Barrett and Chatfield, 1972). The quarry is cut into Upper Chalk and, although abandoned, there is still a fresh face of chalk some 15–20 feet high facing slightly south of east. Chalk fragments are weathered from the well jointed and bedded chalk of this face and collect as scree at its foot. Beyond the scree is a flat area with a soil cover. There are trees both around and within the quarry (sycamore and hawthorn) and these help to keep the area well shaded and fairly moist. The scree and quarry floor are covered by various grasses, ivy (*Hedera helix*), ground elder (*Aegopodium podagraria* L.), nettles (*Urtica dioica*) and sorrel or sourdock (*Rumex acetosa*). There is also a variety of scattered cultivated shrubs and plants that recall the former use of the site for a café and a garden. The scree itself commonly has a lower density of herbs and is characterised by a fairly abundant growth of algae on the chalk fragments, especially in the shade of bushes. There are also scattered patches of moss including *Eurhynchium praelongum* and *Brachythecium rutabulum*.

FEEDING EXPERIMENTS

Initially a number of *Discus rotundatus* were collected from this habitat, placed in pairs in petri dishes and given food. The food was selected on the basis of that

available in the quarry at the time of year (January 1971). Chalk fragments were placed in each petri dish as well as plant material, though some control dishes with paper and chalk only were established. It was soon apparent that the snails on algae—whether of small, middle or adult sized animals—were feeding and producing green faecal strings. Microscopic investigations confirmed that these strings contained algae.

As a result of this preliminary work, more detailed investigations were made into the feeding of *D. rotundatus* on algae, with special reference to the growth of immature specimens.

EXPERIMENT 1

For the first group of experiments using algae, a number of *D. rotundatus* of various sizes were collected from the quarry and starved for a week. Petri dishes of snails were set up on 22 February and individual snails were differentiated by coloured paint. Sets A and B were of 4 mm. snails, C of 3 mm. and D mostly of 2 mm. Set E included snails of various sizes and was included to check any effect of the paint on the growth of the snails. Each 10 mm. petri dish contained three or four snails together with small lumps of chalk on which algae was growing. The chalk was obtained from the quarry. It was soaked in water to maintain moistness and a few drops of distilled water were added to each dish to keep the relative humidity high. Sets F and G were set up as controls, using chalk and filter paper. Since the filter paper proved rather coarse, a finer type of paper was introduced from 12 March. As the experiment was set up, each snail was carefully marked at the shell lip with Pelikan drawing ink.

The snails were kept indoors in a centrally heated study where the normal diurnal range was about 3·3–4·5 °C. The lowest temperature recorded was 10·6 °C. and the highest 21 °C. Humidity was kept high by adding water regularly to the dishes. The dishes were inspected at intervals of about a week and the growth of new shell at the lip measured with a calibrated micrometer eyepiece in a monocular microscope. The snails were then marked again and the food in the dishes changed. Estimates were made of the faeces and recorded on an arbitrary scale of nil, rare, common and abundant. Thus it was possible to establish whether the snails were feeding and to follow subsequent shell growth. This experiment was followed from 22 February until 13 April, a total of 55 days.

The results of Experiment 1 are shown in Fig. 1. These graphs show that there were considerable variations in the total amounts of growth for individuals, and also in their rates and patterns of growth. In set A, feeding on algae, all snails grew rapidly for about five weeks, after which there was a decline in the rate of growth. However, one snail grew much more rapidly than the rest and attained a total growth of nearly 5 mm., compared with about 2 mm. for the other three. In set B, also feeding on algae, the general pattern of growth was similar to that of set A although the total growth showed greater individual variation. The range of total growth was, however, similar.

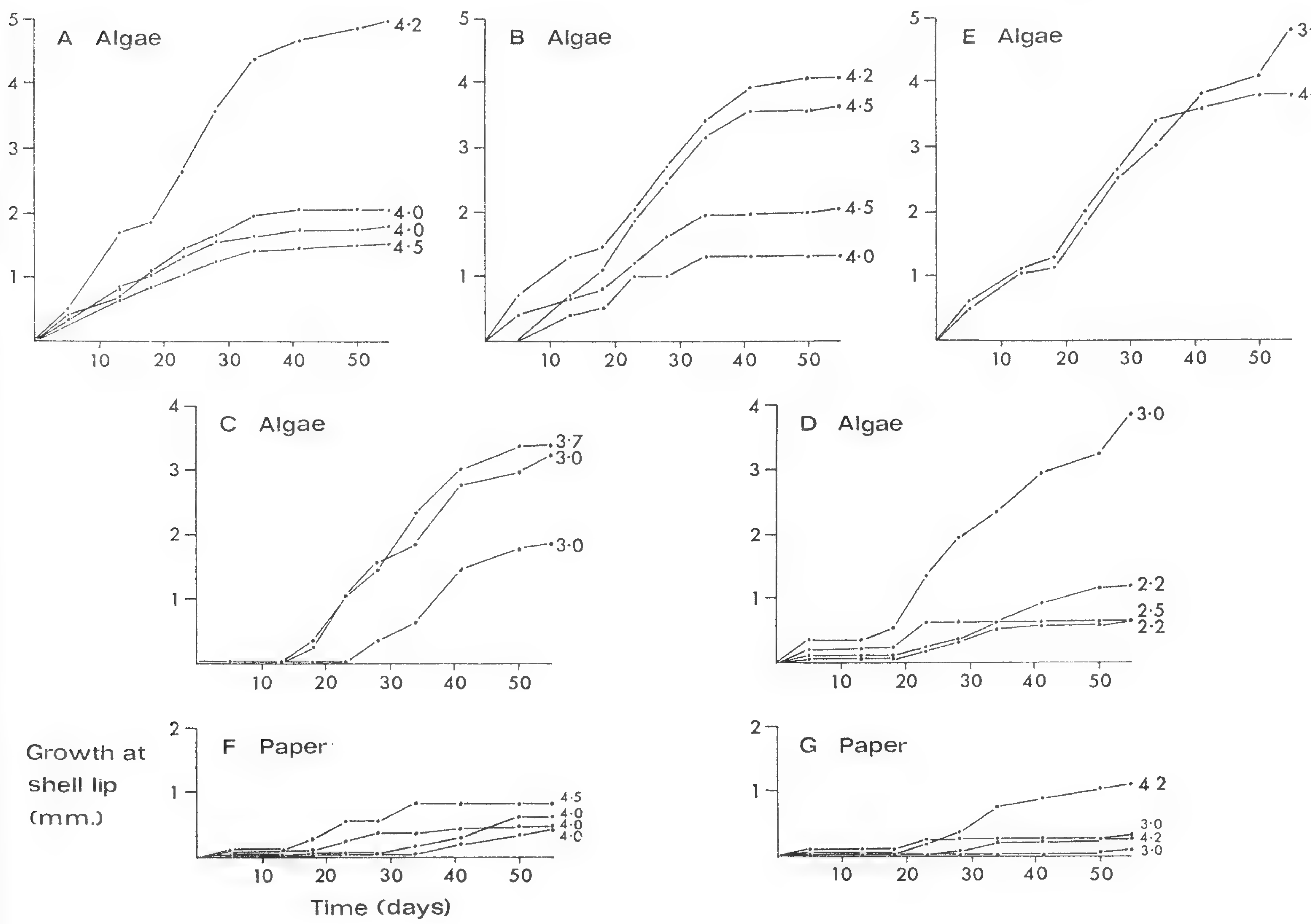

Fig. 1. Experiment 1: to show growth at the shell lip of immature specimens of *Discus rotundus*. Sets A – E feeding on algal encrusted chalk; F – G feeding on paper and chalk. The initial diameter of each snail (mm.) is shown. Temperature 10·6 – 21·0°C.

Whereas sets A and B were of 4 mm. snails, set C consisted of snails of 3 mm. diameter. In this set there was no growth at first (when few faeces were recorded) but after two weeks the snails grew rapidly. Two of the snails achieved a lip growth of more than 3 mm. in six weeks and the third nearly 2 mm. in four and a half weeks. The range of growth fell within the same limits as sets A and B. Set D, mostly of 2 mm. snails, showed slow growth at first (and few faeces), but after 18 days began to grow more rapidly. In this latter feature set D resembled set C, but for the most part at a slower rate of growth. The exception was a snail of 3 mm. and this grew rapidly, after 18 days, to a total of nearly 4 mm. The total growth for the 2 mm. snails was between 0·6 and 1·2 mm. The snails in set E grew rapidly and fairly regularly throughout the period of the experiment. The 3 mm. snail in this set grew a total of nearly 5 mm., this being the greatest total growth for any snail in the experiment excepting one in set A. The 4 mm. snail grew nearly 4 mm. at its lip, and showed a general slowing in the rate of growth after five weeks.

Sets F and G, feeding on paper, showed some growth during the experiment, but the individual totals were less than those feeding on algae. Of the eight snails in these control sets, only one showed a lip growth of more than 1 mm. over the 55 days. The range in set F was between 0·4 and 0·9 whilst in set G three snails

grew individually 0·3 mm. or less. The patterns of growth, as in most of the algal sets, were somewhat irregular but the rates of growth were slower.

Observation of faecal output showed that the snails in the experiment were feeding. In those sets feeding on algae the faeces were usually rated as abundant. In the sets on paper the amounts of faeces varied between common and rare on the arbitrary scale, with some emphasis towards common.

EXPERIMENT 2

A second experiment of a similar kind was set up on 26 June. Sets comprising 5 mm. petri dishes each containing three snails were set up and on this occasion the individual snails were differentiated by size and not by coloured paint. Thus each set contained snails of approximately 5 mm., 4 mm. and 3 mm. diameter. The sets were kept and fed under conditions similar to those for Experiment 1 excepting that the temperatures in the study at this time of year varied between 15·5°C. and 27·2C. with a diurnal range of not more than 5·5°C. In July the minimum temperatures were above 19°C., and were usually above 21°C. The growth of new shell at the lip was measured every four days between 26 June and 24 July, the experiment lasting 28 days. Sets 1 and 2 were fed on small pieces of algal encrusted chalk, whilst sets 3 and 4 were given various kinds of paper and pure chalk. The two larger snails in set 1 died and were replaced on the twelfth day. On 8 July a further two sets of snails were established and fed on chalk with algae until 24 July. Set 5 comprised three snails and set 6 four snails. These snails were kept and measured under the same conditions as sets 1–4.

In set 1 (Fig. 2) the 3·0 mm. snail grew just over 6 mm. at its lip, the 4·0 mm. snail grew just over 2 mm. and the 5·3 mm. snail grew less than 1 mm. The smallest snail not only grew the most but also grew quickly and almost regularly throughout the 28 days when measured at 4-day intervals. After their late introductions, the 4 mm. snail showed a similar pattern of growth whilst the large snail grew slowly and irregularly.

In set 2 the largest snail again showed the least growth. The 4·1 mm. snail grew quickly at first and more slowly later to a total of nearly 5 mm. of lip growth. The 3·2 mm. one grew more slowly and irregularly to nearly 4 mm. of lip growth. The control sets, numbers 3 and 4, feeding on paper, showed little growth during this experiment, with one notable exception. But even in this case the rate of growth slowed greatly after 12 days.

Sets 5 and 6, which were fed on algae, again showed that *D. rotundatus* can grow on this food. Total amounts varied and the rates of growth were irregular for individual snails. However, as in sets 1 and 2, growth rates for the smaller snails tended to be rapid.

In Experiment 2 faecal output was again measured. In sets 1, 2, 5 and 6 the amounts of faeces were found to be abundant on the arbitrary scale, whilst in sets 3 and 4 they were usually rare (i.e. present, but in small quantities). These findings were essentially the same as those in Experiment 1.

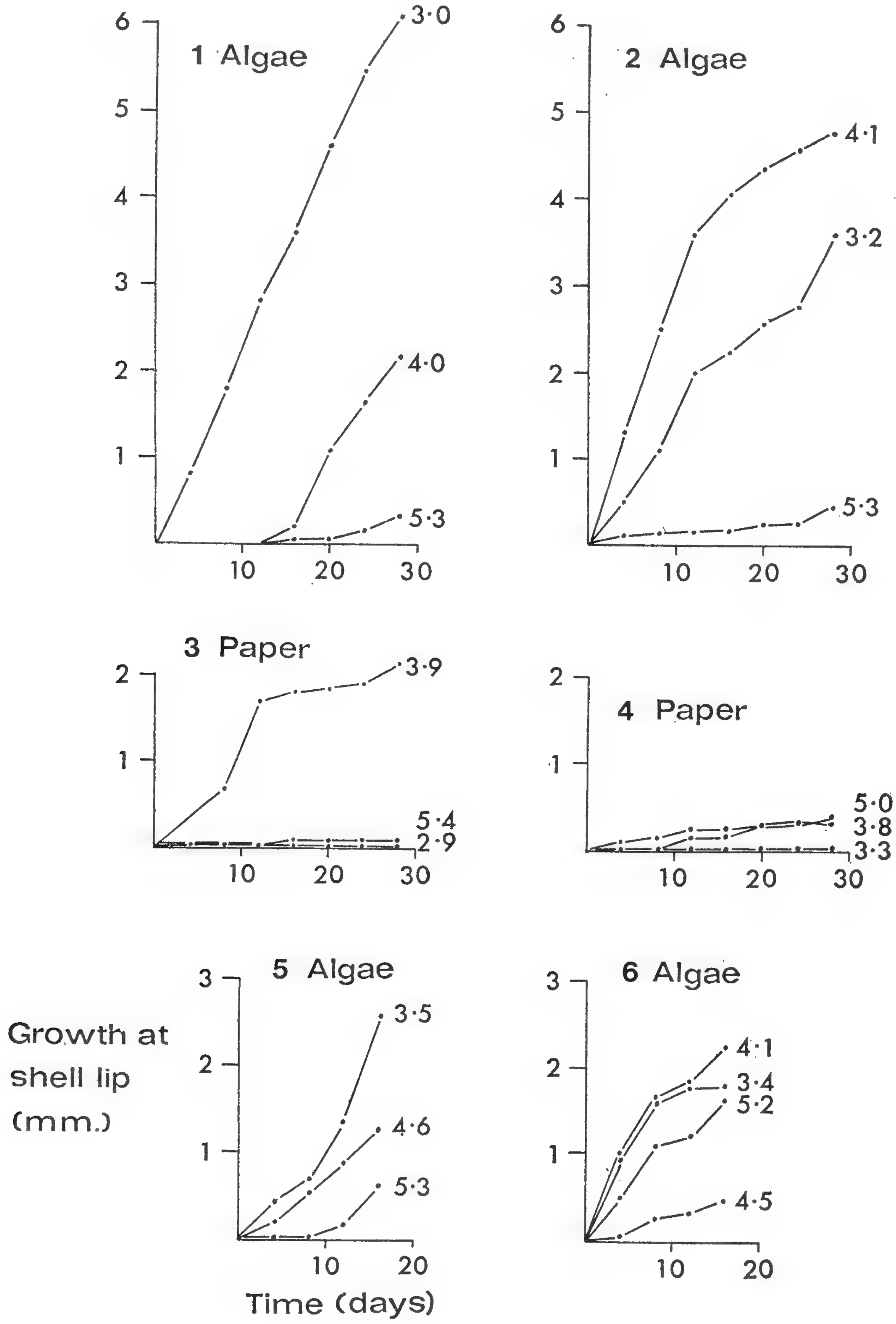

Fig. 2. Experiment 2: to show growth at the shell lip of immature specimens of *Discus rotundatus*. Sets 1, 2, 5 and 6 feeding on algal encrusted chalk; 3 – 4 feeding on paper and chalk. The initial diameter of each snail (mm.) is shown. Temperature 15·5 – 27·2°C.

EXAMINATION OF FAECES

During these experiments, faeces were collected, fixed in 70% alcohol, mounted in Berlese fluid and examined with a monocular microscope. At low powers of magnification only a green cloud was seen, but higher powers showed small roundish green bodies. These observations compared very closely with slides made by the same technique using fresh algae from the chalk, and with slides of the faeces of other populations of *D. rotundatus* both from the quarry and from other habitats. The algae on the chalk has been identified as belonging to the order Chlorococcales.

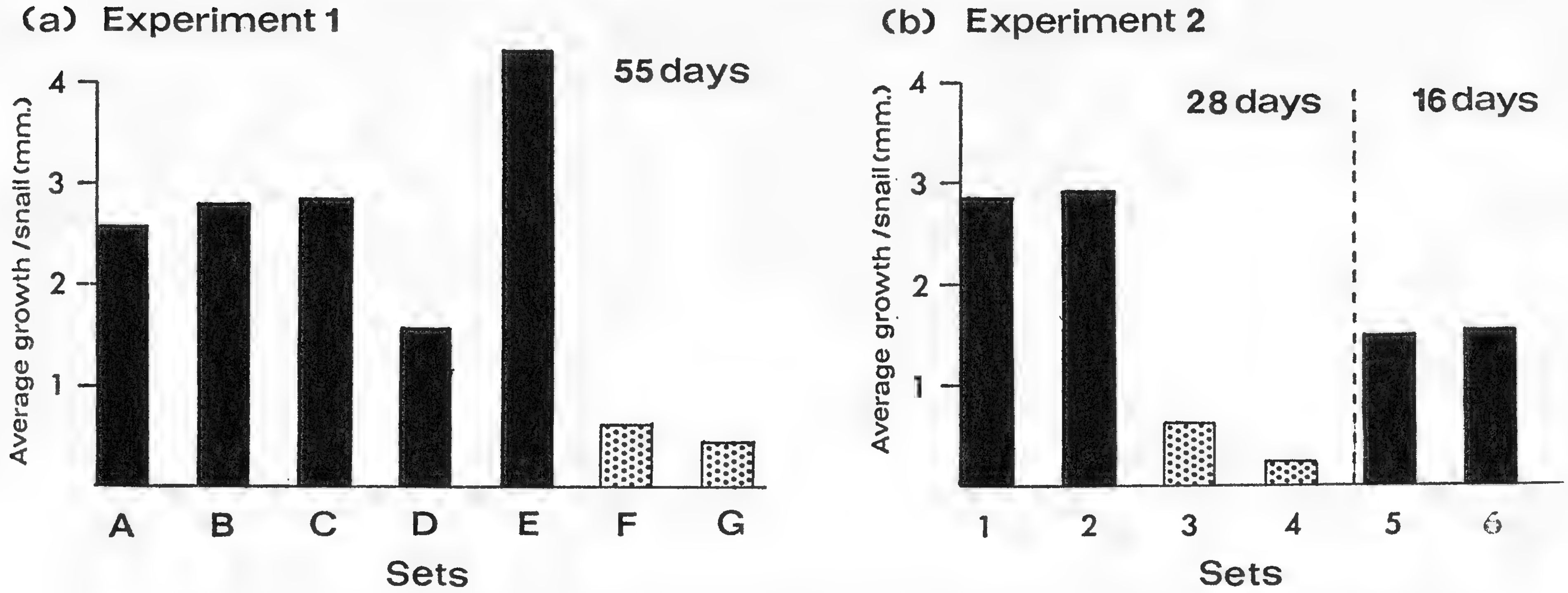

Fig. 3. Column graphs to show the average total growth at the shell lip per snail per set. (a) Experiment 1; (b) Experiment 2.
Key: ■ feeding on algal encrusted chalk; ░ feeding on paper and chalk.

The slides of the algae collected from the quarry and of the faeces in Experiments 1 and 2 were seen to include, in addition to the algae, small amounts of fungal spores and hyphae. It is therefore possible that the snails obtained some nutrient from these. However in the slides of faeces the fungi were seldom damaged, which suggests that the snails might have had difficulty in breaking the outer walls during feeding and digestion. The nature of the outer wall of the fungal hyphae would seem to support this.

Thus from the evidence of the slides, and the nature and small amounts of the fungal material present, it would seem reasonable to deduce that it is the algae which is responsible for most of the lip growth in the snails in Experiments 1 and 2. Also, care was taken to select only fresh and bright patches of algae for the feeding experiments.

DISCUSSION

Total growth

Experiments 1 and 2 described and illustrated above show that immature *Discus rotundatus* were able to grow on a diet of green algae and chalk during the periods of the experiments. There were, however, considerable variations in the total amounts of growth achieved by individual snails at the lips of their shells. In Experiment 1, lasting 55 days, this varied between 0·62 mm. and 4·94 mm., and in Experiment 2 (28 and 16 days) between 0·32 and 6·1 mm. Since the experiments varied in their duration, these figures are better expressed in terms of the average rates of growth per day. These give a range of from 0·01 mm. to 0·09 mm. a day for snails in Experiment 1 and 0·01 mm. to 0·22 mm. in Experiment 2.

The variations in total amounts of growth per snail occurred not only across each experiment, but also within each petri dish. The graphs of each of the sets on algae in both experiments show this clearly (Figs. 1 and 2), those in set B, for

example, giving values of 1·3, 2·06, 3·66 and 4·08 mm. total growth for each of the four snails. Such variations in total growth for individuals are not unusual in pulmonate land snails.

An inspection of the relative sizes of the snails suggests some limited correlation between size and growth achieved. The 2 mm. snails in set D showed smaller amounts of total growth and consequently a lower average rate of growth per day than the larger snails in Experiment 1. The average rate of growth per day of 2 mm. snails was only 0·014 mm. compared with 0·054 mm. for the larger snails in Experiment 1. However, other experiments currently in progress do not confirm the trend shown in Experiment 1 towards lower rates of growth for 2 mm. snails except in the most general way. Also there was a suggestion that in sets 1 and 2 of Experiment 2 those of 5 mm. or over grew more slowly than smaller snails in the same sets. Although sets 5 and 6 show some exceptions, other experiments currently in progress show that the larger immature snails vary greatly in their potential for growth. Thus if snails of this size are chosen for experimental work, an irregular pattern of results often ensues. It may be that these snails are too close to maturity to give regular results.

From the figures given above of total growth and average rates of growth for *D. rotundatus*, together with Fig. 1 and Fig. 2, it is clear that most of the snails in Experiment 2 grew more rapidly than those in Experiment 1. This difference may reflect the higher temperature during Experiment 2, when it was also noted that larger quantities of algae were being consumed.

In both experiments there was a marked contrast between the total growth of those snails on algae and those on paper (Fig. 3). In Experiment 1 the snails on paper grew only between 0·08 and 1·1 mm., compared with 0·62 and 4·94 mm. on algae. Although the 2 mm. snails on algae showed similar total amounts of growth to those on paper, when total growth for snails of comparable size is averaged per snail, a growth of 0·51 and 3·03 mm. is revealed for those snails feeding on paper and algae respectively. The column graph (Fig. 3), which averages the growth per snail per set, shows clearly that those fed on algae achieved more growth than those on paper (over 1·5 mm. cf. about 0·5 mm.). For comparable sized snails, this graph shows that the average growth per snail is much greater on algae than on paper (2·5 mm. cf. about 0·5 mm.).

Similarly, but with one exception, the snails on paper in Experiment 2 showed much less growth at the lip than those on algae. Five of the six on paper grew less than 0·4 mm. each, a figure which was the minimum growth for all but one snail in this experiment on algae. When average amounts of growth per snail per set are calculated (Fig. 3b), the results show the same trends as those in Fig. 3a.

However, the fact that the snails in both these experiments were able to grow on paper, if only slowly, is difficult to explain since it is known that snails need protein for shell growth. There is the possibility that *D. rotundatus*, like *Helix pomatia* L. may be able to utilise some of the cellulose available in paper (Stone and Morton, 1958), but it seems unlikely that paper is the source of protein. An

alternative explanation may be that the snails are using protein from body materials.

Patterns of growth

The experiments on the growth of *Discus rotundatus* when fed on algae reveal not only the total growth achieved, but they also show the patterns of growth between successive measurements at the lip. The use of average growth per day figures used above tend to obscure these patterns that derive from the measurement of lip growth at frequent intervals. Further experiments based on daily measurements may show growth patterns more clearly.

The graphs in Fig. 1 show that there is a tendency towards a similar pattern of growth for the individuals within each set. Since the external conditions affecting these sets were the same, it would seem that variations within the petri dishes from one set to another affected the patterns of growth. Some of these patterns seemed to correspond with the amount of faeces produced. Superimposed on these patterns are the individual variations in the rates of growth (Fig. 1).

There was a tendency for similar trends in the sets feeding on algae in Experiment 2, especially if the 5 mm. snails —which it has been shown may be a special case—are ignored. The steepness of the lines on the graphs in Fig. 2 reflect the relative rates of growth of individual specimens. In Experiment 1 they show that snails of all sizes above 3 mm. are capable of almost equally rapid growth when feeding on algae. The most rapid rate between two successive measurements was 0·15 mm. per day, while the minimum was nil. But it was characteristic of these snails in this experiment that these rates were rarely maintained and the variations in the angles of the growth lines on the graphs reflect the irregularity of the patterns of growth of individual snails. The 2 mm. snails showed slower maximum rates of growth and have flatter growth line patterns on graph D.

In Experiment 2 there were again variations in the pattern of growth of most individuals, though some were fairly constant (e.g. the 3 mm. snail in set 1). As in Experiment 1 most of the snails on algae were capable of most rapid growth, the most rapid between successive measurements being 0·32 mm. per day. These rates were much greater than the maximum rates in Experiment 1, which further suggests the significance of temperature in growth rates.

In the sets feeding on paper in Experiment 1, the maximum rate of growth between successive measurements was 0·06 mm. per day, as against 0·18 for snails feeding on algae. These figures and the appearance of the graphs (F and G in Fig. 1) confirm that the snails on paper grew much more slowly than those on algae. With the exception of one snail, those on paper in Experiment 2 show the same general features, but in view of the much more rapid growth of the sets on algae in this experiment, the visual comparison is more acute.

When Experiment 1 was set up, one set of snails was established without paint, as a control. In Fig. 1 it can be seen that this set (E) showed the greatest total growth per snail. Also, in Fig. 1, graph E records particularly constant and rapid rates of growth. There might therefore be a case for claiming that the paint or

its solvent slightly affected the growth of the snails in the other sets in Experiment 1. However, other variables must also be considered such as the possibility of a different microhabitat in petri dish E quite apart from the variations in growth rate that characterise individual snails. Even if this result is accepted as it stands, the rates and total amounts of growth still resemble those in Experiment 1 rather than those of Experiment 2.

SUMMARY

This paper refers to the feeding and growth of *D. rotundatus* on green algae of the order Chlorococcales growing on natural chalk from a quarry. Some indoor experiments were set up which, together with field observations, enable certain conclusions to be reached as listed below.

1. Both mature and immature snails of this species eat algae under natural and experimental conditions.
2. Indoor experiments showed that immature specimens of all sizes above 2 mm. could grow on a diet of algae and chalk if kept in a humid environment. Snails above 5 mm. in diameter were rather irregular in their growth.
3. Individual specimens of *D. rotundatus* grew different total amounts even when kept under similar conditions.
4. The individual snails showed different patterns of growth over a given period, reflecting different rates of growth between successive measurements besides different total amounts of growth. However, there was a tendency for snails in the same artificial habitat to show similar trends in growth patterns.
5. The variations in total growth and maximum rates of growth between Experiments 1 and 2 suggest that specimens grow more and faster in warmer conditions providing sufficient algae is available.
6. Control sets fed on paper and chalk also showed variations in total growth and in patterns of growth, but clearly grew much less (with one exception) than the sets on algae. Also, they were unable to grow as fast.
7. The fact that *D. rotundatus* will grow at all on paper raises some interesting questions about the food potential of the various papers used and the possibility that this species may be able to utilise cellulose in feeding.

ACKNOWLEDGMENT

We are grateful to Dr. A. E. Round for help with the identification of the algae.

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REVIEW

Marine Shells of the Pacific Northwest by Tom Rice. Pp. 102,, Pls. 40 in colour, map. Of Sea and Shore Publications, P.O. Box 33, Port Gamble, Washington 98364, U.S.A. Price $2.70 by post.

This little book from the prolific pen of the Editor of the magazine 'Of Sea and Shore' provides a remarkably complete and attractive guide to the mollusca which can be found between Alaska and Northern California. The text relates mainly to range, habitat, and constant or distinguishing characteristics of the various species. All the forty plates are in colour, photographed by a special direct-colour process which really does provide good lifelike results, and an interesting and helpful feature of the book is that most of the species are photographed in groups of from two to six specimens, all natural size, showing different aspects and variations. Good 'regional' books are of the greatest use to general collectors, and there are not nearly enough of them; this one provides collecting and conserving hints, a glossary and short list of clubs, all of which make it most suitable for use by the beginner, but the short and very clear notes on each species provide a good deal of value as a reference book for the advanced collector also. Altogether a handbook which will be found essential for anyone interested in the mollusca of this area, and which can be recommended without reservation.

Mary Saul

J. Conch. **28**: 23–35 (1973)

PATTERNS OF SNAIL DISTRIBUTION AT HAM STREET WOODS NATIONAL NATURE RESERVE, EAST KENT

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(*Read before the Society, 21 October 1972*)

1. INTRODUCTION

Until recently the documentation of National Nature Reserves has not been pursued intensively with regard to the Mollusca, although lists of general occurrences are available for many reserves. During 1972 the writer made a series of collecting forays at Ham Street Woods NNR in east Kent, in an attempt to map snail distribution in detail. Eleven days were spent in field work, during a period extending from early March to late May. Collecting was done in daytime and mostly in dry weather.

2. DESCRIPTION OF SITE

The reserve consists of a triangular area of approximately 96 hectares, just to the north of Ham Street village (TR010340). Most of it occupies the eastern half of the valley of a short, southward-draining obsequent stream, three branches of which run through the woods. The catchment area is about 230 hectares and mainly on Weald Clay. The valley is one of several which hereabouts dissect the old cliff-line marking the northern landward borders of Romney Marsh. Heights above ordnance datum in the reserve range from 6 metres in the southwest corner to 46 metres at the rim of the valley. Rainfall lies within the 635 mm.–700 mm. isohyet. Records from the nearest gauging station at Sellingde (TR086382) for the past five years average 585 mm. per annum, at a slightly greater altitude of ca. 60 metres. Potential evapo-transpiration of the region is calculated as a deficit of about 180 mm. in the year, between May and August.

The woods are considered a good example of oak/hazel and hornbeam coppice, with much sweet chestnut and white and silver birch coppice, with some alder, field maple and aspen, and a few ash, beech and other standards. There is a notable insect fauna and the Conservancy has revived the coppice cycle to encourage those species with dependent life-cycles. Besides recently coppiced areas, there are also broad rides, some open canopy and glades which reduce shading.

Superficial deposits occur at the principal breaks in slope of the valleys; the materials appear quite structureless in sections and are likely to be due to solifluxion. Solid deposits include siltstones of the top Tunbridge Wells Sand which occupy a narrow tract along the lower part of the main stream valley, whilst the higher ground along the north-eastern margin brings in a sandy facies of the Weald

Clay. A hill-top regolith of Large Paludina Limestone occurs to the east of the reserve, but no drainage from this area enter the wood.

Generally there is a brown forest soil with a mull humus formation covering much of the surface. The upper few inches of soil have a range of pH from 5·0 to 6·9, but most values fall between 5·5 to 5·8. At depth intervals between 1·5 and 2·1 metres pH drops to slightly alkaline values, ranging from 7·5 to 8·0. Two recent analyses of stream soils suggest that a relatively large range of pH will occur (5·5 and 6·9) and a similar variation is known for the base constituents. The soils of the valley floors are described as a waterlogged basic gley. Judging from the spread of *Mercurialis perennis* L., waterlogging is largely seasonal and not permanent.

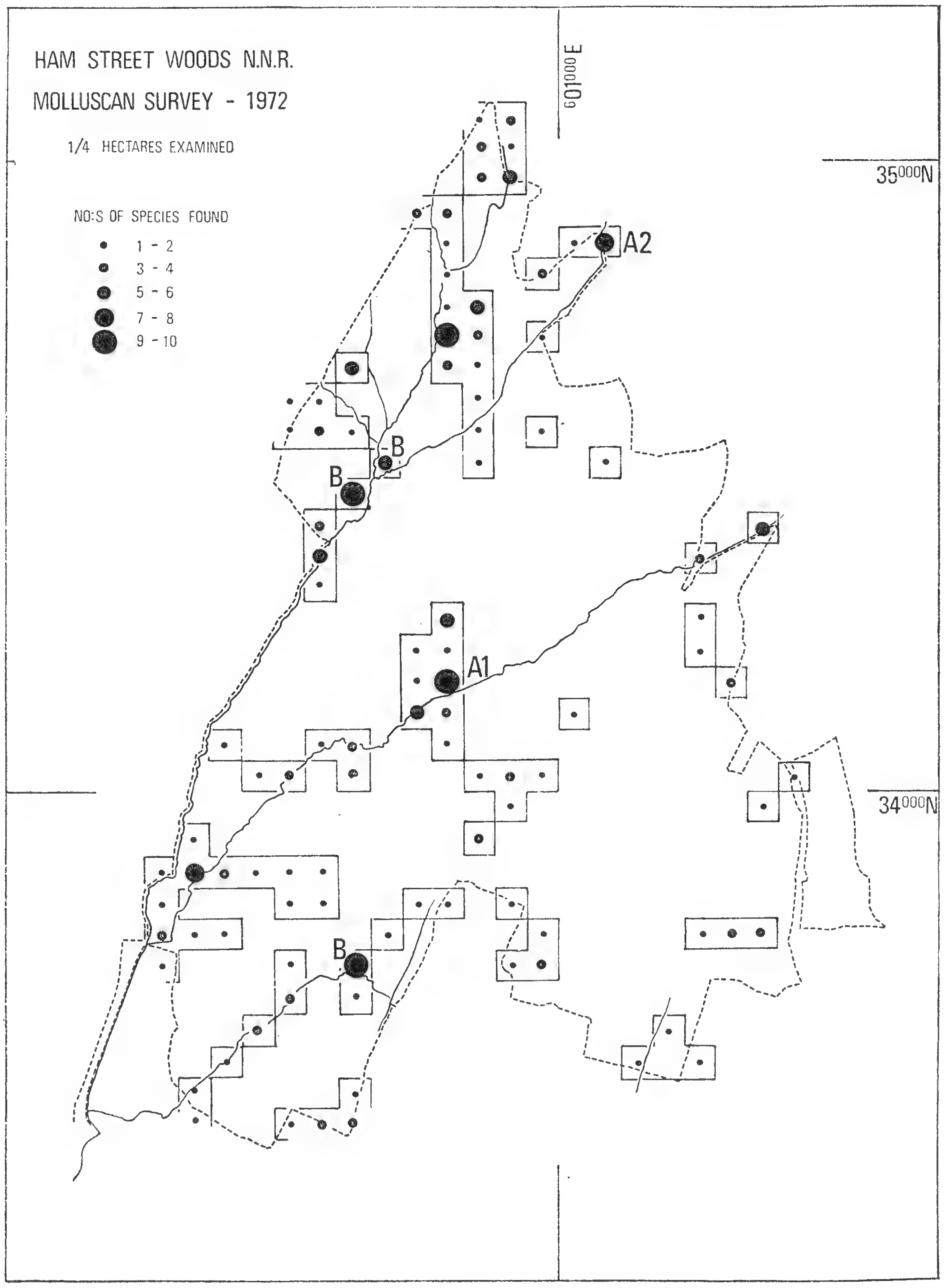

Fig. 1. Ham Street Woods National Nature Reserve; Molluscan Survey 1972. Quarter hectares examined and numbers of species found in each.
A1, 2 – soil analyses sites; B – stream basins referred to in text.

3. METHODS

Searching and sampling were based on a quarter-hectare grid, with intervals marked off from the intersection of the 1-kilometre lines 01oooE and 34ooo and 35oooN in the reserve (see Fig. 1). About one quarter of the area of the wood was searched, attention being concentrated on the most favourable niches, i.e. the lower strata of leaf litter, sub-cortical and ventral spaces of old stumps and prostrate timber, lower parts of thick herb layers, streams and ditches, certain rather infrequent basins in the stream courses, and also their adjacent slopes. Concrete culverts were wiped round inside with a ball of damp clay impaled on a long stick. Permanent and drying ponds, including a rather acid sphagnum swamp carr, were fished with a net.

4. SPECIES PRESENT

Thirty-four species are known to occur, including slugs and aquatic forms. Five of those in the list below were not seen by the writer.

Carychium minimum Müller
Carychium tridentatum (Risso)
Lymnaea truncatula (Müller)
Lymnaea pereger (Müller)
Cochlicopa lubrica (Müller)
Acanthinula aculeata (Müller)
Clausilia bidentata (Ström)
Cepaea nemoralis (L.)
Hygromia hispida (L.)[1]
Punctum pygaeum (Draparnaud)
Discus rotundatus (Müller)
Arion intermedius Normand
Arion hortensis Férussac
Arion subfuscus (Draparnaud)
Arion ater ater (L.)
Arion ater rufus (L.)
Euconulus fulvus (Müller)
Vitrea crystallina (Müller)
Vitrea contracta (Westerlund)
Oxychilus cellarius (Müller)
Oxychilus alliarius (Miller)
Retinella radiatula (Alder)
Retinella pura (Alder)
Retinella nitidula (Draparnaud)
Milax budapestensis (Hazay)[1]
Limax maximus (L.)
Limax cinereoniger Wolf[2]
Lehmannia marginata (Müller)[1]
Agriolimax reticulatus (Müller)
Agriolimax laevis (Müller)
Agriolimax circumscriptus Johnston[1]
Agriolimax silvaticus Lohmander
Sphaerium lacustre (Müller)
Pisidium obtusale (L.)

NB [1] recorded by J. B. Hall, 1964
[2] recorded by E. G. Philp

5. DISTRIBUTION OF SPECIES IN HABITAT

Sixteen species of snail were mapped, using the grid squares outlined in Fig. 1. This map also summarises the distribution of species numbers. Complimentary data on the utilisation of the differing niches available by species is summarised in Table 1. Other maps (Figs. 2 to 5) illustrate presence or absence data for individual species in the squares sampled and searched.

TABLE 1

HABITAT	*D. rotundatus*	*O. alliarius*	*R. nitidula*	*E. fulvus*	*R. radiatula*	*O. cellarius*	*V. crystallina*	*C. lubrica*	*R. pura*	*P. pygmaeum*	*C. tridentatum*	*Cl. bidentata*	*C. minimum*	*C. nemoralis*	*V. contracta*	*A. aculeata*
	SPECIES															
Various stream loci and adjacent ground*	●	●	●	●	●	●	●	●	●	●	●	●	●		●	●
Leaf litter	●	●	●	●	●	●	●	●		●						
Prostrate timber	●	●	●	●	●	●	●									
Rotting stumps (ventral & lateral† surfaces)	●	●	●	●		●	●				●					
Grass and herbs at wood margins; glades*	●	●	●									●		●	●	
Stumps and logs in new-cut coppice	●	●	●	●		●										
Young coppice (3–4 yr.) – stumps, logs, leaf litter	●	●	●	●												
Concrete culverts				●				●								
Tree holes, coppice stools, tops of stumps	●	●			●											
Charred timber	●	●	●		●	●	●									
Number of $\frac{1}{4}$-ha. squares in which species occur	86	63	20	28	16	14	13	9	3	4	10	2	8	3	1	

Utilisation of habitat by the sixteen species of mollusc mapped in the current survey at Ham Street Woods NNR, 1972.
* Includes logs and leaf litter enclosed by the locus. † At soil level or under bark.

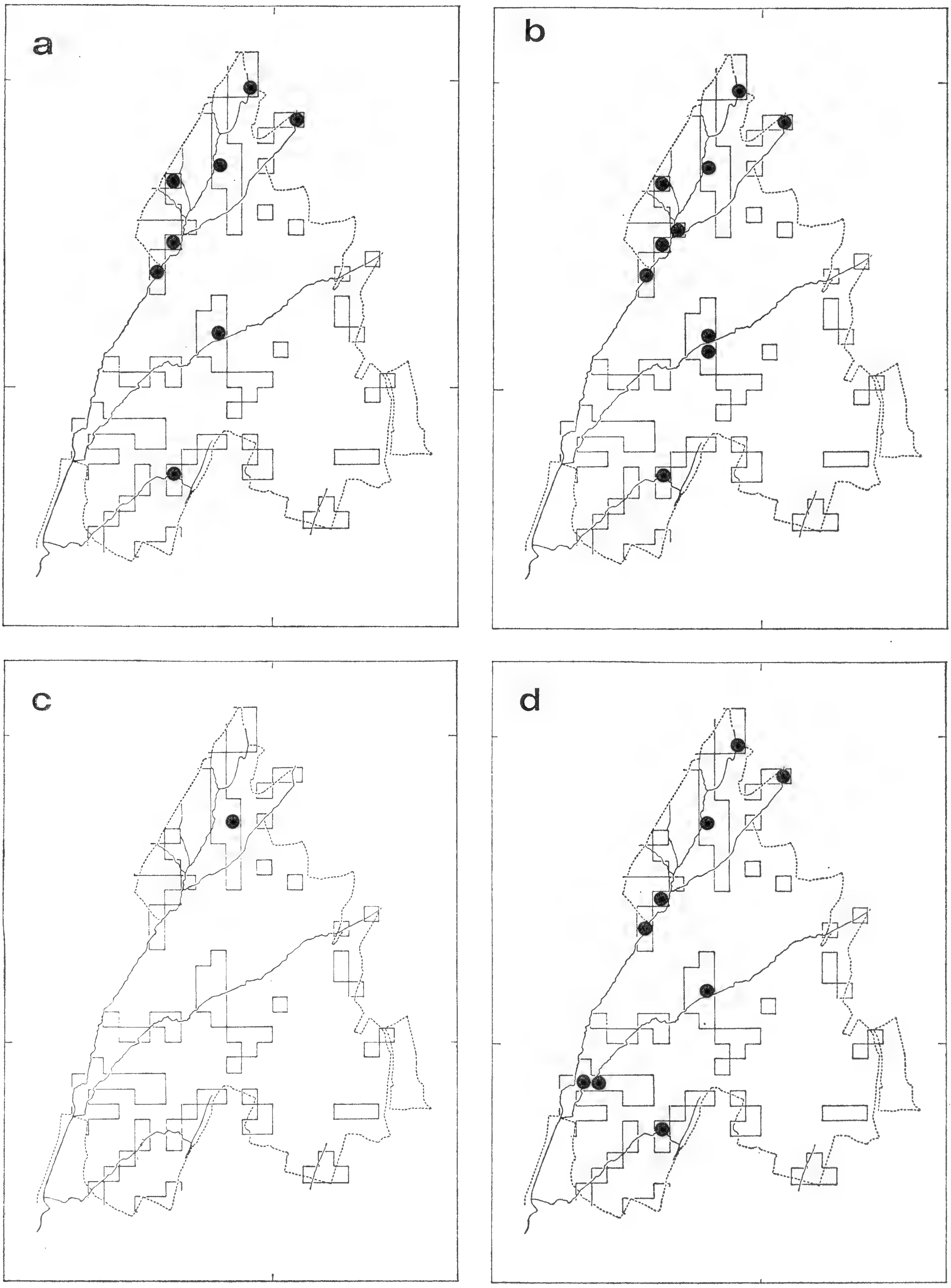

Fig. 2. a. Carychium minimum; b. Carychium tridentatum;
c. Acanthinula aculeata; d. Cochlicopa lubrica.

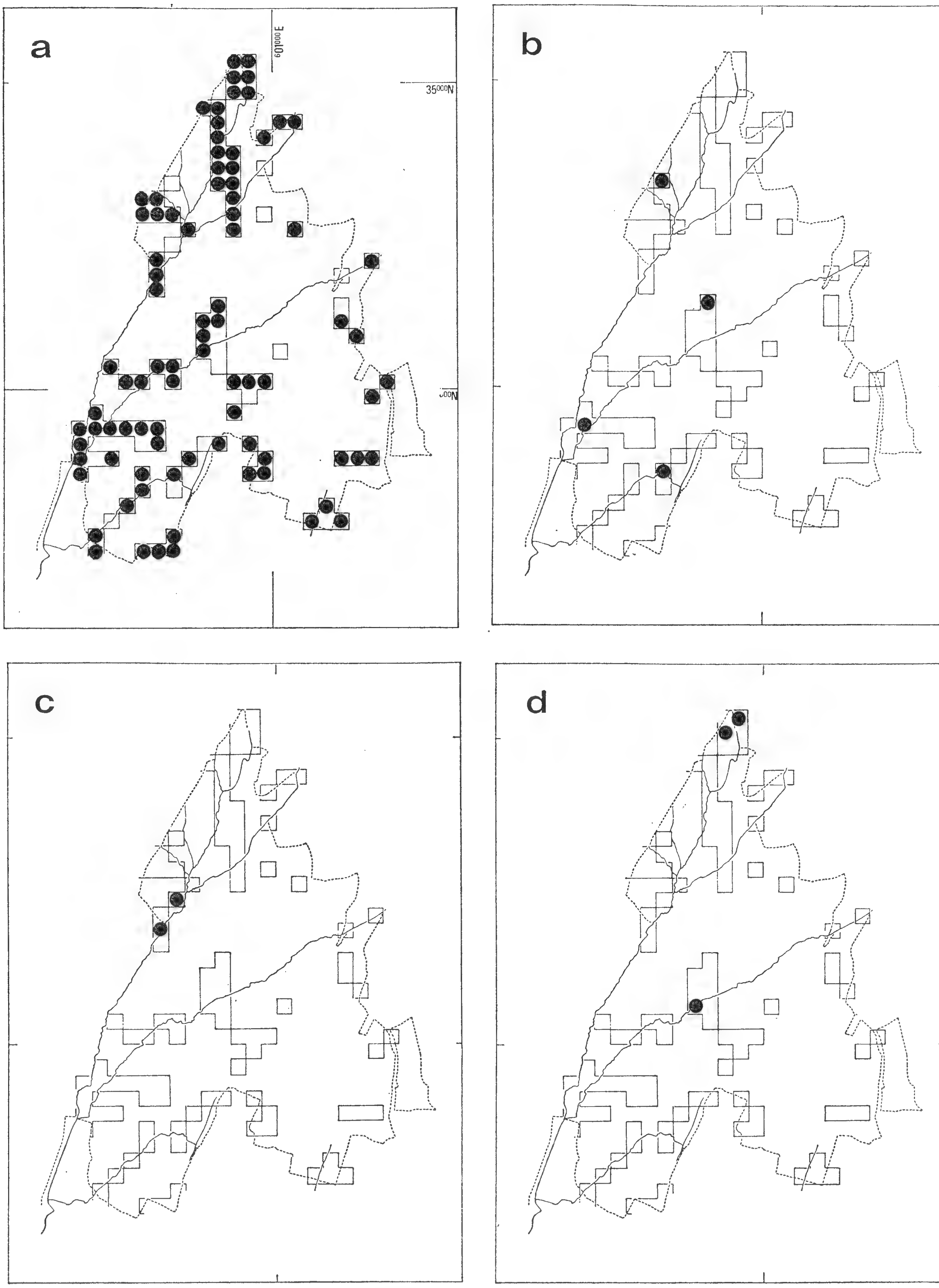

Fig. 3. a. Discus rotundatus; b. Punctum pygmaeum; c. Clausilia bidentata; d. Cepaea nemoralis.

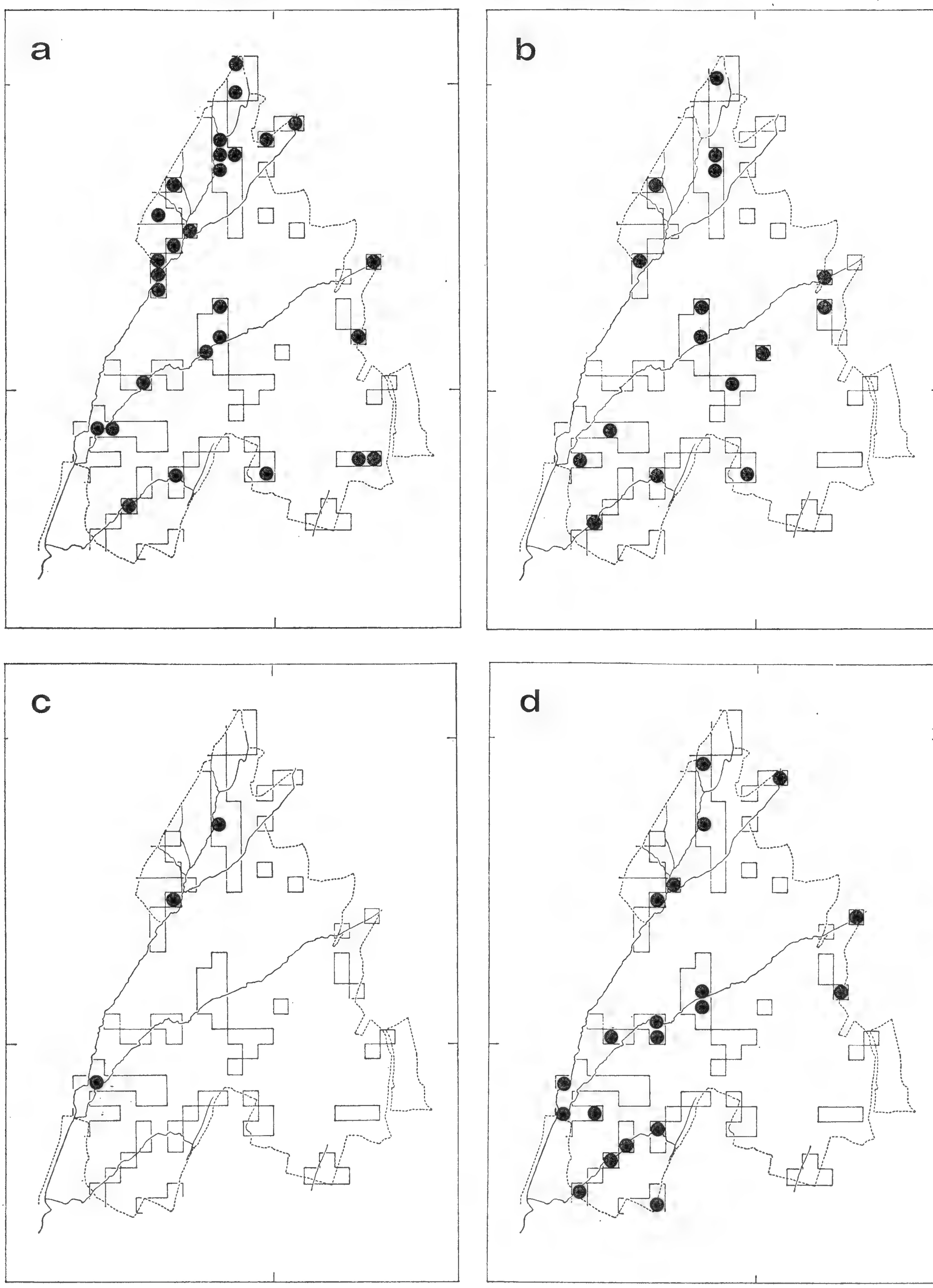

Fig. 4. a. *Euconulus fulvus;* b. *Retinella radiatula;*
c. *Retinella pura;* d. *Retinella nitidula.*

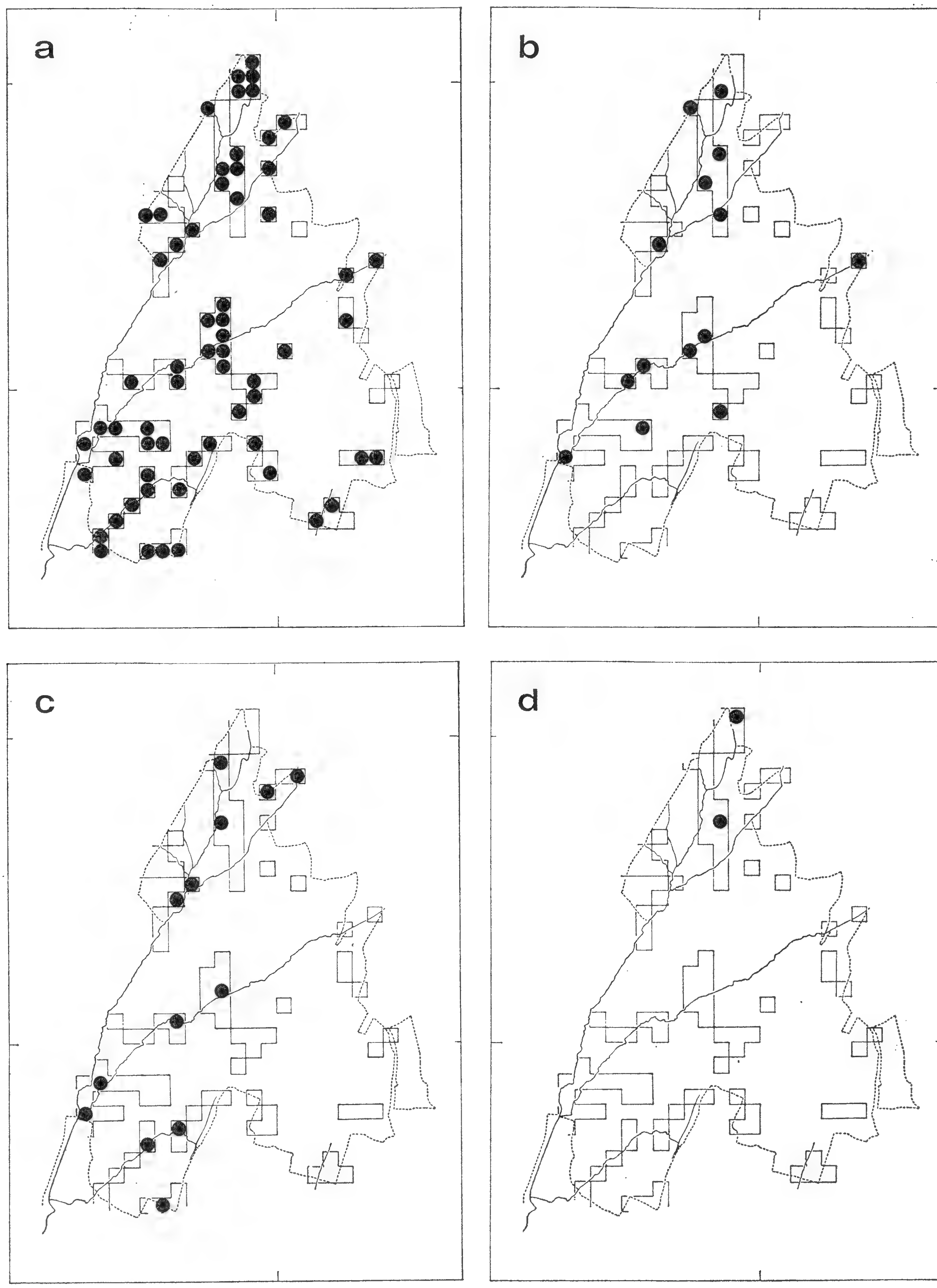

Fig. 5. a. *Oxychilus alliarius;* b. *Oxychilus cellarius;* c. *Vitrea crystallina;* d. *Vitrea contracta.*

The number of squares in which species occur, given at the foot of Table 1, corresponds also with impressions of abundance. *Discus rotundatus* and *Oxychilus alliarius* are certainly the most commonly encountered species. *Vitrea contracta, Acanthinula aculeata* and *Cepaea nemoralis* are represented by very few records and little can be said about their distribution at this stage. With the exception of the two species of *Carychium*, also *Discus rotundatus, Oxychilus alliarius, Euconulus fulvus* and *Clausilia bidentata* (Ström), individuals are nowhere numerous and never abundant.

Fourteen of the quarter-hectare squares sampled contain five or more species of snail (see Fig. 1). Of these, only two squares lie outside the stream environs. Six loci with seven or more species are recorded and all lie within the valley floors. All sixteen species are found in these favoured situations, but the sparse records for *Acanthinula aculeata, Vitrea contracta* and *Cepaea nemoralis* suggest the need for further searches.

Four species—*Discus rotundatus, Oxychilus alliarius, Euconulus fulvus* and *Retinella radiatula* are widely distributed in the wood. *Retinella radiatula* occasionally outnumbers *Discus rotundatus* in $\frac{1}{4}$-metre^2 samples, but it is generally, as Boycott observes (1934, 12) "never abundant or even common" and certainly restricted at Ham Street in its choice of habitat (see Table 1). This species is amongst Boycott's "facultative xerophiles" (1934, 17) but conspicuously absent from the drier situations in the wood, for example newly coppiced compartments—perhaps because it shuns the ventral surfaces of stumps and seldom creeps into fallen timber.

Oxychilus cellarius, Euconulus fulvus and *Retinella nitidula* show some preference for stream niches and the last species appears much more commonly in the lower and wetter south-west corner of the reserve.

Cochlicopa lubrica, Retinella pura, Carychium minimum and *tridentatum, Vitrea crystallina* and possibly *Punctum pygmaeum* seem to constitute a fairly distinct "valley group" although single occurrences of the last three species lie away from the valley floors. *Retinella pura* and *Punctum pygmaeum* are known from four and three loci respectively, in small numbers—a half hour's search and subsequent examination of litter samples never produced more than three *pura*. Alder (1831) *in* Ellis (1969) comments "not frequent".

6. FACTORS AFFECTING DISTRIBUTION

Relative humidity, availability of calcium (not necessarily as soil carbonate, but also the more soluble citrate and other salts in leaf litter) and the hydrogen-ion concentration are usually regarded as the local influences in woodland habitats which may determine, directly or indirectly, numbers, species variety and distribution (see e.g. Wäreborn, 1970). Mechanisms of dispersal, about which so little is known with certainty, are also much more likely to be significant in the scrutiny of very local patterns.

The six species of the valley group are ones which generally do best in moister,

nutrient-rich conditions (Valovirta, 1968; Bruijns *et al.*, 1959, Waldén, 1955; Wäreborn, 1970). Diver's voluminous and detailed records for Studland Heath, Dorset (unpublished, undated) provide much generally confirmatory data. These references give more detailed hints of needs of the individual species considered. The numbers of *Cochlicopa lubrica* drop sharply at a litter pH of less than 5·6 (Valovirta) and breeding success is profoundly influenced by the type of calcium salt available (Wäreborn) calcium citrate being more beneficial than the oxalate. *Retinella pura* requires stable, undisturbed conditions for some part of its life cycle (Waldén, 1969) preferring lime or elm woods (which produce also more citrate) and primaeval forest. *Cochlicopa lubrica*, *Carychium minimum* and *Punctum pygmaeum* are thought to be resistant to changes due, for example, to drainage works and general woodland interference. *Puctum pygmaeum* is said by Valovirta to favour a rather acid medium (pH 5·6 to 6·0) but, according to Wäreborn this species and *Retinella pura* prefer nearly neutral conditions greater than pH 6·5. *Punctum pygmaeum* is also favoured by higher calcium values in leaf litter and both this species and *Cochlicopa lubrica* are found by Bruijns to be typical of the richer soils in woodlands. The two species of *Carychium* do better in areas with higher values of soil calcium (Boycott, 1934; Watson and Verdcourt, 1952) and appear together in biotopes intermediate between marshland and woodland. Waldén (1969) seldom found *tridentatum* in oakwoods in southern Sweden.

At Ham Street the normal tendency for the foot of slopes to be moister than the higher parts is accentuated by a number of factors. The spurs between the principal drainage lines often have a relatively steep gradient—one-in-four to one-in-six is not uncommon. Rainfall is rather meagre and the theoretical evapotranspiration deficit in the region relatively high (see section 2) between May and August, so that clay surfaces tend to become excessively dry. A recent auger transect across one of these spurs, folowing a long, dry summer, showed uniformly dry soil profiles to a depth of ca. 60 cm. to the very edge of the streams and an absence of the soil transitions normally associated with moister, down-slope conditions. The long-term management plans for the reinstatement of oak-woods characteristic of this part of Kent have led to much clearing, and, as noted above, coppicing is still practised. A great deal of the valley floors, however, has a dense understorey or relatively undisturbed history, which tends to preserve more humid conditions along the stream courses. These factors tend to accentuate the value of the stream valleys as humid refuges.

The availability of calcium is affected by leaching processes occurring on slopes (see Salisbury, 1921) and the effects of a relatively impermeable surface associated with coppicing will apparently intensify the transfer of the more soluble calcium salts from humus, soil and litter to the valley floors (cf. Boormann and Likens, 1967). In addition, the rate of decomposition and its completeness in leaf litter and dead wood is also greatly speeded in water (Thomas, 1970). Perhaps little calcium is likely to be available to surface drainage from the underlying Weald Clay, apart from that translocated through plants; *total* calcium in this deposit is sometimes below 0·2%. Virtually all the drainage entering the wood comes

from the sandy facies with associated mottled clays—a type not generally calcareous (B. Worrsam, personal communication). Thomas considered that "the calcium released from decomposing leaves is undoubtedly more important biologically in streams which drain non-calcareous watersheds". Locally at least, this appears to be the case.

Among tree species in the stream valleys, alder, aspen, hornbeam and hazel are the more numerous individuals, the first two favouring humid and nutrient-rich places. In addition, ash, white birch, sallows, dog-wood and the occasional spindle tree also suggest higher nutrient levels, some being calcicole species as well. *Mercurialis perennis*, a reputedly "eutrophic" indicator species, forms frequent extensive swards and *Urtica dioica* L. is often well-grown in the less shaded situations, indicating relatively high phosphorus and nitrogen levels (Piggott, 1970). Aspen, hazel, dogwood and ash store much calcium in their leaves, varying with levels in the substrate. Ash litter provides calcium citrate. All of the best loci (with nine or ten species) and nearly all those with more than five species have in common the presence of hazel, a few ash, alder and aspen or drainage from similar adjacent areas which may enhance calcium supply.

The species-rich loci at Ham Street are, nevertheless, not rich in soil calcium and (*Carychium* and *Clausilia* apart) do not entertain very numerous molluscan individuals. Although Wäreborn (1969) has shown that soil calcium has less significance than levels in litter or förna, exceptions to this view are possible when mollusca appear to be living directly upon the soil surface. Analyses of the top centimetre or so of soil from two loci in drainage lines having ten and seven species respectively (position given in Fig. 1, A) are given in Table 2, with values for exchangeable bases in parts per million. Very few *Carychium* were found at the first site (both species) and only on rotting wood. At the second both species colonise the bare soil surface and possibly feed there on organic films. Fifteen individuals were collected from an area of approximately 1/16 metre^2. It appears that *Carychium* starts to thrive at levels of about 3000 ppm. of exchangeable calcium. A large proportion of the material would be loosely bound to organic detritus and translocated through bacterial or fungal slimes and mycelia, whose growth must also be influenced by higher phosphate levels.

Taken in general, the snail clusters in these small valleys make a fitful and sporadic appearance. Most of the sites with five or more species are subject to seasonal deluges, as indicated by snagged debris. The streams which run through the three small basins having six or more species (see Text Fig. 1, B) have far fewer species and individuals on their banks above and below these points. Apart from the factor of nutriment, deposition of snail-bearing flotsam following a deluge might account for these foci, as they are obvious traps for stream-borne detritus. Small species, such as *Vitrea crystallina*, which was found totally immersed and live on two occasions, can probably meet their respiratory requirements (i.e. elimination of carbon dioxide and the redemption of any temporary oxygen debt) by unassisted diffusion through the exposed body surface.

TABLE 2

	pH	P_2O_5	Loss on Ignition	Est. Carb.	K	Na	Ca	Mg	Mn	Ground Flora	Shade	No. of Snail Species
A1	6·9	38	9·38%	3·9%	238	64	1950	589	786	Mercur.	Dense	10
A2	5·5	190	23·1%	10·2%	550	232	3140	500	170	Urtica	Partial	7

Analyses of the top centimetre of soil from two stream loci at Ham Street Woods NNR, 1972. The position of these sites is marked A1, A2 in Fig. 1. Elements and phosphates are given as parts per million, dry weight basis.

7. OTHER FEATURES OF DISTRIBUTION

Elsewhere in the reserve, examination of recently coppiced areas or compartments suggests that cutting and the associated disturbance of the substrate eliminate Mollusca almost completely. This will hardly come as a surprise to anyone who has contemplated the nakedness of such areas. However, a few individuals of the hardier species may be found by extensive examination of old stumps, or another type of congenial refuge produced by clearing up, with much the same water retaining properties and alkaline crevices—namely, partially burned wood. The leaf litter is broken up and blown away. Thin swards of wood anemone and other vernal ground layers which spring up in the following season are, like the mosses which cover much of the bare clay surfaces, far too dry to attract Mollusca. Prior to cutting, dense coppice stands of single tree species are, in any event, host to few snails and it may be that not much is lost.

In those compartments occupied by high canopy, exclusively oak woodland, local distribution of snails sometimes appears to be controlled by the growth or lack of an understorey. It seems that turbulent winds blowing down through the canopy redistribute the years leaf-fall until trapped in occasional patches of *Rubus*, etc., leaving sterile areas of thin, dry litter tenanted by mites and a few baby slugs and notably lacking the hygrophile polydesmid millipedes and lithobiomorph centipede characteristic of the reserve, *Lithobius variegatus* Leach. Interception of rainfall and its evaporation from the canopy no doubt contribute to the apparent dryness of these situations. Among the thicker patches of trapped litter two or three of the hardier species make an appearance (*alliarius*, *rotundatus*, *radiatula*) typically about twenty individuals in a square metre. Perhaps it is simply the presence of more persistent moisture and a variety of leaf type which encourages general litter activity. The stump faunas of the dry areas of oakwood are very poor, containing fewer individuals than newly coppiced compartments. A prolonged search is necessary to discover even the ubiquitous *Discus rotundatus*.

Apart from the need for an extensive system of moist interstices, there is an obvious association of snail faunas with the apparent vigour of the decomposer cycle. Subdued activity in leaf litter is a good general indication of a paucity of snails, both in terms of numbers and species. Besides the obvious effects of dryness, referred to above, this may also be linked to textural and mechanical properties of the litter. Among wet chestnut leaves, for example, which are particularly adherent when moist, forming aggregates with few interstices, there are very few of the usual litter invertebrates and still fewer snails.

The F and H layers of the humus are likely to contain a large proportion of nutriments from the litter, but very few living snails were found there. Some researches suggest (e.g. Frankland *et al.*, 1963) that rainfall selectively removes into this zone accumulated acids from the litter, so that the humus tends to remain more persistently acid, whilst the litter "improves" becoming neutral or even alkaline.

To conclude: in these notes an attempt has been made to describe observed

clustering or species aggregation in coppice woodland on poorly calcareous Weald Clay, and account in a hypothetical way for this distribution. The small stream valleys in the woods provide much topographical contrast and this, in conjunction with a low average rainfall and large deficit in water balance, is perhaps of overriding importance. The clear pattern seen at Ham Street is unlike that known from other woods in the region, notably Blean Woods NNR (3 miles north-west of Canterbury) where it seems that age of coppice, low relief and position in catchment are more important.

8. ACKNOWLEDGMENTS

Dr. M. P. Kerney steered the writer carefully round taxonomic pitfalls common to the novice and gave much encouragement. Mr. John Maylam and David Maylam provided willing guidance and ready help in the field. Dr. D. F. Ball of the Conservancy's Pedology Section provided sample analyses and helpful comments on these.

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J. Conch. **28**: 37–39 (1973)

A NOTE ON THE ACCEPTABILITY OF VARIOUS WEEDS AS FOOD FOR *ARION HORTENSIS* FÉRUSSAC

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(*Read before the Society, 21 October 1972*)

During 1968 a study was made of the acceptability of 26 species of common weeds as food for the pest species of slug *Agriolimax reticulatus* (Müller), and it was discovered that while there were definite preferences, and a wide range of species were acceptable, some species of weed were rejected. Pallant (1969) added to the list of acceptable species, experimenting with the woodland plants *Veronica montana*, *Glechoma hederacea*, and *Ranunculus ficaria*. It was thought of use to repeat the study of the acceptability of common weeds using *Arion hortensis* Férussac, which is also a pest species of slug.

The same method was used as before. The slugs were housed separately in cartons, and kept moist, this time damp blotting paper being used in the bottom of the cartons. The lid of the carton was of thin transparent polythene through which fine holes were pierced. The lid was sprayed with water daily, and the blotting paper moistened. To test each species of plant, ten cartons were supplied with leaves, and a daily record was kept for a week of the leaves eaten, so that seventy observations were made for each species of plant. The work was done in spring and early summer when the leaves were most succulent. The palatability of 27 species of plants was investigated, and the results are listed below in four categories of acceptability. The rejection of *Dactylis glomerata* was so anomalous compared with the result obtained testing *Agriolimax reticulatus*, where it was placed in the highest category of acceptability, that the experiment was repeated the following year using younger leaves, but the same result was obtained, i.e. virtual rejection of this grass.

The results are listed below in approximate order of their acceptability.

Eaten readily	(Accepted in $\frac{30\text{–}65}{70}$ instances)
Cruciferae	*Capsella bursa-pastoris* L.
Chenopodiaceae	*Chenopodium album* L.
Compositae	*Taraxacum officinale* L.
Gramineae	*Agropyron repens* (L.) Beauv.
Eaten less readily	(Accepted in $\frac{20\text{–}30}{70}$ instances)
Papaveraceae	*Papaver rhoeas* L.

Caryophyllaceae	*Stellaria media* (L.) Vill.
Umbelliferae	*Aegopodium podagraria* L.
Rubiaceae	*Galium aparine* L.
Compositae	*Senecio vulgaris* L.
Solanaceae	*Solanum nigrum* L.
Labiatae	*Lamium purpureum* L.
Polygonaceae	*Polygonum aviculare* L.
Eaten occasionally	(Accepted in $\frac{10\text{–}20}{70}$ instances)
Ranunculaceae	*Ranunculus repens* L.
Compositae	*Bellis perennis* L.
Convolvulaceae	*Convolvulus arvensis* L.
Labiatae	*Lamium album* L.
Urticaceae	*Urtica dioica* L.
Virtually rejected	(Accepted in $\frac{0\text{–}10}{70}$ instances)
Onagraceae	*Epilobium hirsutum* L.
Onagraceae	*Circaea lutetiana* L.
Araliaceae	*Hedera helix* L.
Compositae	*Achillea millefolium* L.
Rosaceae	*Fragaria vesca* L.
Gramineae	*Dactylis glomerata* L.
Polygonaceae	*Rumex obtusifolius* L.
Scrophulariaceae	*Veronica persica* Poir
Euphorbiaceae	*Euphorbia peplus* L.
Plantaginaceae	*Plantago lanceolata* L.

CONCLUSION

The four categories of acceptability were filled to approximately the same extent as in the similar study of *Agriolimax reticulatus*, except that in the highest level of acceptability, $\frac{30\text{–}65}{70}$ instances, only four species could be included against ten in the case of *Agriolimax*. *Chenopodium album*, *Taraxacum officinale*, *Agropyron repens*, *Papaver rhoeas*, *Aegopodium podagraria* and *Bellis perennis* were equally acceptable in the cases of the two species, whereas in both instances *Hedera helix*, *Epilobium hirsutum*, *Euphorbia peplus* and *Fragaria vesca* were rejected.

Achillea millefolium and *Plantago lanceolata* were rejected by *Arion*, whereas the *Achillea* and *Plantago* species were in the highest category of acceptance for the *Agriolimax* series of experiments, and the anomaly of the rejectance of the grass *Dactylis glomerata* has already been mentioned.

Getz (1959), experimenting with *Arion circumscriptus*, *Deroceras** *reticulatum* (Müller) and *Deroceras** *laeve* (Müller) found approximately 11 species of plants

* = *Agriolimax*

were readily accepted, 11 were reluctantly eaten, while 22 were rejected. *Taraxacum officinale* was amongst those readily acepted, and *Plantago lanceolata* only relatively accepted or refused, which accords with the degree of acceptability found above, but otherwise different species of plant were used, so that no further comparison can be made. Nevertheless, again, a wide range of food was available to these species in America.

It can be concluded from these results that again many common weeds are acceptable to *Arion hortensis* too, and that again, most habitats will contain an adequate supply of food, which contributes towards the success of the species and their wide distribution.

Pallant (1969) thought it unlikely that dead plant remains were eaten by *Agriolimax reticulatus* to any great extent. This point has not yet been investigated for *Arion hortensis*.

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J. CONCH. **28**: 40 (1973)

A RARE "SOWERBY" LEAFLET

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(Read before the Society, 19 May, 1973)

In Collins' checklist of Sowerby works (1969) a number of single-sheet items are enumerated, and this reminded me that I possessed one such item which did not seem to be included.

My example is a leaflet entitled "Description of a New Bulinus. 1853. Bulinus Wrightii; G. B. Sowerby, Sen.", and comprises a single sheet of text and a fine coloured plate by C. C. Sowerby (i.e. Charlotte Caroline Sowerby, niece of G. B. Sowerby I). The plate is numbered "I" which is curious if the leaflet was issued as a separate publication, as seems to have been the case.

I am indebted to Dr. C. R. C. Paul for the information that the leaflet is mentioned by Shuttleworth (1856), Kobelt (1893) and Pilsbry (1904), but nevertheless it seems to be very rare. My copy may have belonged to F. P. Marrat (1820–1904) the Liverpool conchologist who throughout his long life was in touch with the Sowerbys.

Pain and Paul (1967 : p. 44) refer to the leaflet and accept it as a valid publication. The position of such leaflets is doubtful; Marrat issued a number of somewhat similar leaflets (see McMillan, 1961): he stated in print that they were "for distribution to friends and correspondents" which suggests that they were in fairly general circulation. Certainly he gave copies to the library of the Conchological Society, for general use by members.

If Sowerby's leaflets were similarly distributed there seems no objection to accepting them as valid publications.

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THE OCCURRENCE OF *CHARONIA LAMPAS* (L.) AT GUERNSEY

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(*Read before the Society, 21 October 1972*)

The large Triton, *Charonia lampas* (L.), has its centre of distribution in the Mediterranean, extends south to the Canary Islands, and is well known on the coasts of Spain and Portugal. Between 1825 and 1847 three, or possibly four specimens were reported from the seas around Guernsey (Crowley, 1961). The first discovery was made by a fisherman, James Ozanne, who dredged the mollusc from near the Casquets in August 1825. The Casquets are a group of rocks about 20 miles north of Guernsey. These discoveries extended the range of the species a considerable distance northwards, and into British waters. At the time there were those who doubted whether the discoveries were genuine, and in a letter to the *Annals and Magazine of Natural History* in 1859, Clarke wrote, "Those who believe this to be a British species have more faith than I can lay claim to". Jeffreys replied to this in a subsequent issue of the same journal saying, "My belief that this is a British species is founded upon the fact that Mr. Lukis is a gentleman of unquestionable veracity". F. C. Lukis was the Guernsey naturalist who had reported the discoveries of the animal.

More than a century passed with no further occurrences of this species in the Channel Islands area, and many biologists must have shared Clark's suspicions that the Guernsey specimens had in fact been dredged much further south and brought to the island for sale to collectors. Now, in 1972, 125 years after the last discovery, three further specimens have been collected. A fishing industry for the Queen scallop (*Chamlys opercularis* (L.)) has developed in Guernsey during the last year or two, and in early July 1972 a fisherman, Mr. Brian Cable, was dredging for Queens about nine miles south of Guernsey when the first moderate-sized Triton was found. This was eaten as a large whelk by one of his crew. A few days later in the same area a larger specimen was dredged, and this one was taken to the Guernsey aquarium where it was seen by local naturalists, and where, at the time of writing in October, it continues to live happily. The living specimen is 22 cm. long, and was possibly feeding on the Queens in the area from which it was collected.

During the last week in September 1972 a party of students from University College, Swansea, who were in Guernsey on a Field Course carried out some dredging in the Hurd Deep, which is a little to the north of the Casquets where the first specimen was found. They also obtained a large living specimen amongst

their collection, made on the boundary between the Marine Census areas 16 and 17.

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ASSOCIATIONS OF MOLLUSCS AND MARINE PLANTS AT SAN DIEGO, CALIFORNIA

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(Read before the Society, 21 October 1972)

The purpose of this study was to discover which species of molluscs may be found living upon marine plants in Southern California, and how the distribution of species and numbers of individuals varies with the species of marine plant.

The most recent work which includes a survey of the habitats of marine molluscs in Southern California is that of McLean (1969). To our knowledge, no general survey of the association of molluscs with marine plants has been made in the Southern California area. However certain specific associations such as *Notoacmea paleacea* (Gould) with *Phyllospadix* spp., *N. depicta* (Hinds) with *Zostera marina* Linnaeus, and *N. insessa* (Hinds) with *Egregia laevigata* Setchell are well known.

Previous work on such associations from other areas includes that of Bergh (1871), Warmke and Almodóvar (1963) and Duffus (1969). Studies of faunas inhabiting marine plants in which molluscs were noted include the works of Colman (1940), Wieser (1952, 1959), Chapman (1955), Hagerman (1966), Nagle (1968) and Mukui (1971).

METHODS OF STUDY

Collections of plants were made in the tidal range of +1·0 to −1·0 feet (U.S. Department of Commerce, Tide Tables, 1971). This represents the lower mid-tidal and upper low-tidal zones. The samples were taken when the plants were in water 0·5–1·0 m deep. Where possible pure samples of the plant species were chosen. The plant samples were placed in plastic bags under water and cut just above the holdfasts or roots, thus minimising loss of molluscs or contamination with sand and gravel.

The plant samples were returned to the laboratory where each sample was soaked in 20 l of fresh water for 5 min, causing the molluscs to fall to the bottom of the container. The plant material was removed, checked to ensure that no molluscs remained attached, and dried in the air. The plant material was further dried in an oven at 90°C. for 18 hr, and the final dry weight was ascertained.

The residue containing the molluscs, which was left after the water had been decanted, was placed in a small volume of isopropanol and then allowed to dry out. The dry material was separated into size ranges by sieving, and all the molluscs were removed and sorted into species. Empty shells and those containing hermit crabs were discarded. The numbers for each species lot were obtained by

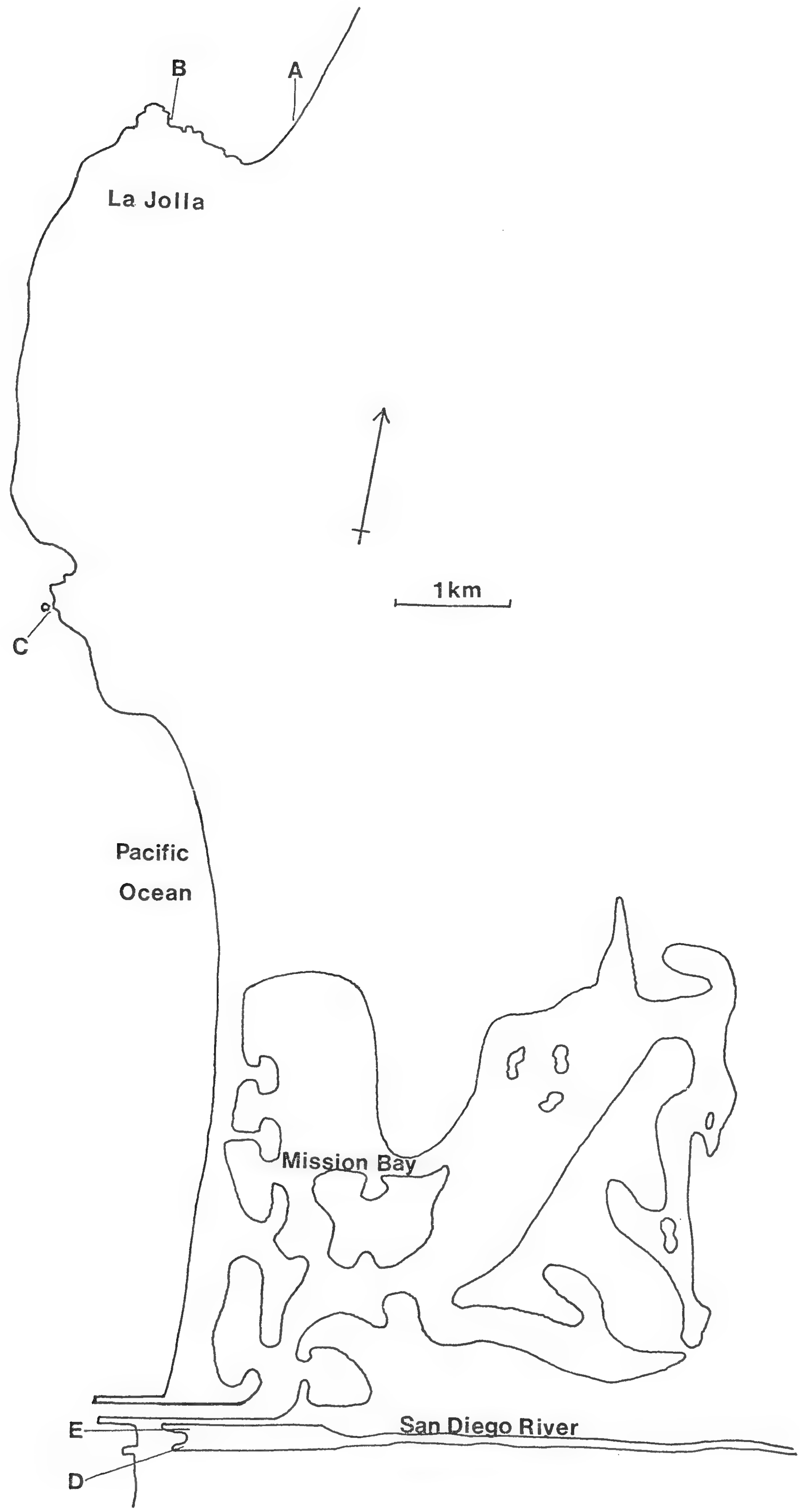

Fig. 1. The areas where seaweed samples were taken in San Diego, with their reference letters.

counting all the individuals. However, in the case of *Barleeia subtenuis* Carpenter the numbers involved were too great. Five lots of 100 individuals were weighed and a mean value for the weight of 100 individuals was derived (deviation $\pm 0{\cdot}2\%$). The total number present was then calculated after weighing each sample. *Barleeia californica* Bartsch and *B. haliotiphila* Carpenter may not be distinguished reliably by shell characters alone. Both species were present in some of the samples, and for simplicity they are described as *Barleeia californica* agg. in the tables.

Collections from an individual locality were made on the same day, within an area of 100 m.^{2} All the collecting was carried out in the period May to August 1971.

RESULTS

Samples of marine plants were taken at five different localities in San Diego (Fig. 1). Areas A, B and C were rocky sites on the outer coast, and Areas D and E were sandy sites in a sheltered bay environment.

Area A was situated 300 m south of La Jolla Beach and Tennis Club. It consisted of rocks and sand with channels, pools and upstanding ledges and was relatively sheltered. Area B was at La Jolla Cove, and consisted of rock pools and channels sheltered from the full force of the surf. Area C was at Bird Rock, La Jolla, where there was a flat shelf with shallow depressions and small boulders which was partially exposed to the surf. Areas D and E were at the seaward end of the Flood Control Channel containing the San Diego River. The mouth of the Flood Control Channel is blocked by a storm beach, and tidal flow occurs through the jetty on the north side, being connected to the open sea via the Entrance Channel to Mission Bay. Area D was a quiet area of sandy mud on the Ocean Beach side of the Flood Control Channel. Area E was near the jetty, the bottom was of clean sand, and there was a strong tidal flow.

Table 1 gives the plant species collected at each locality, and the dry weights of the samples. The following species were included in the study. An account of the flora is given by Dawson (1945).

Marine algae

Division Chlorophyta (green algae)

Ulva sp.

Enteromorpha sp.

Division Phaeophyta (brown algae)

Colpomenia sinuosa (Roth)

Egregia laevigata Setchell

Halidrys dioica Gardner

Sargassum agardhianum Farlow

Division Rhodophyta (red algae)

Corallina spp.

Prionitis sp.

Gigartina spp.

Marine grasses

Family Zosteraceae

Zostera marina Linnaeus

Phyllospadix torreyi S. Watson

The total collection of molluscs obtained from the seaweed samples included the following species. Surprisingly, no shell-less species were found. The nomenclature follows that of McLean (1969).

Gastropoda

Fissurella volcano Reeve
Collisella conus (Test)
Notoacmea insessa (Hinds)
N. paleacea (Gould)
N. depicta (Hinds)
Norrisia norrisi (Sowerby)
Tegula eiseni Jordan
Homalopoma luridum (Dall)
Tricolia compta (Gould)
T. pulloides (Carpenter)
T. rubrilineata (Strong)
Lacuna unifasciata Carpenter
Littorina scutulata Gould
Barleeia californica Bartsch
B. haliotiphila Carpenter
B. subtenuis Carpenter
Vitrinella oldroydi Bartsch
Teinostoma supravallatum (Carpenter)
Caecum californicum Dall
Fartulum hemphilli Bartsch
Bittium quadrifilatum (Carpenter)
Cerithiopsis sp.
Seila montereyensis Bartsch
Crepipatella lingulata (Gould)
Macron lividus (A. Adams)
Nassarina penicillata (Carpenter)
Mitrella carinata (Hinds)
Granula subtrigona (Carpenter)
Granulina margaritula (Carpenter)
Conus californianus (Hinds)
Tenaturris sp.
Haminoea vesicula (Gould)
Acteocina inculta (Gould)
A. harpa (Dall)
Odostomia virginalis Dall and Bartsch

Turbonilla tenuicula (Gould)
T. sp.
Pelecypoda
Mytilus sp.
Septifer bifurcatus (Conrad)
Modiolus sp.
Philobrya setosa Carpenter
Leptopecten latiauratus (Conrad)
Glans subquadrata (Carpenter)
Prothothaca staminea (Conrad)

Table 2 shows that at La Jolla Beach and Tennis Club, *Corallina* and *Gigartina* carried the greatest diversity of molluscs, while *Colopomenia* and *Sargassum* carried the greatest number of individuals. *Tricolia rubrilineata*, *Lacuna unifasciata* and *Barleeia californica* agg. were the most widely distributed among the different plant species, and they and *Caecum californicum* were present in the greatest numbers.

Table 3 shows that at La Jolla Cove, *Corallina* and *Gigartina* again carried the greatest diversity of molluscs, while *Gigartina* carried the greatest number of individuals. *Tricolia rubrilineata* and *Lacuna unifasciata* were the most widely distributed among the different plant species, and they and *Barleeia californica* agg. were present in the greatest numbers.

Table 4 shows that at Bird Rock, La Jolla, *Halidrys* and *Corallina* carried the greatest diversity of molluscs, while *Gigartina* carried the greatest number of individuals. *Tricolia rubrilineata* and *Lacuna unifasciata* were the most widely distributed among the different plant species, and *Tricolia rubrilineata* was present in by far the largest number.

Table 5 shows that at the Flood Control Channel, *Zostera* carried the greatest diversity of molluscs, while *Ulva* at Area D and *Zostera* at Area E carried the greatest number of individuals. *Barleeia subtenuis* was present on all the plants and was exceedingly abundant.

TABLE 1

The dry weight of plant material (in grams), collected at the different areas.

	A	B	C	D	E
Ulva	—	—	—	50	—
Enteromorpha	—	—	—	27	62
Colpomenia	70	—	—	—	—
Egregia	113	76	54	—	—
Halidrys	176	—	87	—	—
Sargassum	86	—	90	—	—
Corallina	266	208	565	—	—
Prionitis	—	138	—	—	—
Gigartina	154	226	162	—	—
Zostera	—	—	—	66	91
Phyllospadix	170	120	218	—	—

A – La Jolla Beach and Tennis Club; B – La Jolla Cove; C – Bird Rock, La Jolla; D, E – Flood Control Channel, San Diego River.

TABLE 2

Numbers of molluscs per kg dry weight of plants collected at La Jolla Beach and Tennis Club (Area A).

	I	II	III	IV	V	VI	VII
Fissurella volcano juv.	17	—	6	—	—	13	—
Notoacmea paleacea	—	—	6	—	—	—	18
Norrisia norrisi	—	—	—	—	4	—	—
Tricolia pulloides	—	—	—	70	—	7	—
T. rubrilineata	—	107	39	603	4	124	6
Lacuna unifasciata	—	98	74	696	—	111	177
Barleeia californica agg.	—	436	29	557	11	91	—
Vitrinella oldroydi	17	—	—	—	—	—	—
Teinostoma supravallatum	—	—	—	—	11	—	—
Caecum californicum	930	—	—	—	80	20	—
Fartulum hemphilli	—	—	—	—	15	—	—
Crepipatella lingulata juv.	17	—	—	—	—	—	—
Macron lividus	—	—	—	12	—	—	—
Nassarina penicillata	—	—	—	—	4	—	—
Mitrella carinata	—	—	—	35	—	111	6
Granula subtrigona	—	—	—	—	4	—	—
Conus californianus	—	—	—	—	8	7	—
Tenaturris sp. juv.	17	—	—	—	—	—	—
Acteocina harpa	—	—	—	—	4	—	—
Odostomia virginalis	—	—	—	—	8	—	—
Philobrya setosa	—	—	—	—	19	7	—
Protothaca staminea juv.	50	—	—	12	—	—	—

I – *Colpomenia,* II – *Egregia,* III – *Halidrys,* IV – *Sargassum,* V – *Corallina,* VI – *Gigartina,* VIII – *Phyllospadix.*

TABLE 3

Numbers of molluscs per kg dry weight of plants collected at La Jolla Cove (Area B).

	I	II	III	IV	V
Fissurella volcano juv.	—	10	7	44	—
Collisella conus	—	—	7	—	—
Notoacmea paleacea	—	5	—	—	—
Norrisia norrisi juv.	—	5	15	4	—
Tegula eiseni	—	5	—	—	—
Homalopoma luridum	—	14	—	—	—
Tricolia pulloides	—	5	—	4	—
T. rubrilineata	119	259	475	761	—
Lacuna unifasciata	26	86	606	264	185
Littorina scutulata	—	—	7	—	—
Barleeia californica agg.	—	278	15	1267	—
Caecum californicum	—	5	—	211	—
Fartulum hemphilli	—	—	—	35	—
Cerithiopsis sp.	—	—	—	4	—
Seila monterevensis	—	—	—	4	—
Mitrella carinata	—	58	51	110	—
Nassarina penicillata	—	5	—	—	—
Conus californianus	—	—	7	—	—
Turbonilla tenuicula	—	5	—	—	—
Modiolus sp. juv.	—	—	—	9	—
Philobrya setosa	—	10	7	53	—
Protothaca staminea juv.	—	24	—	13	—

I – *Egregia,* II – *Corallina,* III – *Prionitis,* IV – *Gigartina,* V – *Phyllospadix.*

TABLE 4

Numbers of molluscs per kg dry weight of plants collected at Bird Rock, La Jolla (Area C).

	I	II	III	IV	V	IV
Notoacmea insessa	3	—	—	—	—	—
N. paleacea	—	—	—	—	—	197
Norrisia norrisi juv.	—	23	—	2	—	—
Tricolia rubrilineata	166	104	77	216	1,164	9
Lacuna unifasciata	110	403	77	7	117	55
Littorina scutulata	—	—	—	—	12	14
Barleeia californica agg.	—	12	—	—	—	—
Crepipatella lingulata juv.	—	—	—	2	—	—
Mitrella carinata	—	35	—	18	92	9
Turbonilla sp.	—	1	—	—	—	—
Mytilus sp. juv.	—	—	—	2	—	—
Septifer bifurcatus	—	12	—	—	—	—
Philobrya setosa	—	—	—	5	—	—
Glans subquadrata	—	—	—	2	—	—

I – *Egregia*, II – *Halidrys*, III – *Sargassum*, IV – *Corallina*, V – *Gigartina*, VI – *Phyllospadix*.

TABLE 5

Numbers of molluscs per kg dry weight of plants collected at the Flood Control Channel, San Diego River (Areas D and E).

	Ulva	*Enteromorpha*		*Zostera*	
	D	D	E	D	E
Notoacmea depicta	—	—	—	60	11
Tricolia compta	—	—	—	—	11
Lacuna unifasciata	—	—	—	—	44
Barleeia subtenuis	15,860	5,800	7,430	11,210	44,300
Bittium quadrifilatum	398	1,020	—	75	—
Mitrella carinata	—	—	16	—	341
Granulina margaritula	119	—	—	90	66
Haminoea vesicula	—	—	339	—	—
Acteocina inculta	199	584	—	—	—
Leptopecten latiauratus	20	—	—	—	22

TABLE 6

Dominance of mollusc species (as a percentage of those individuals present) on eight plant species at La Jolla (Areas A, B, and C). The mollusc species present to less than 1·2% on all weeds have been ommitted.

	I	II	III	IV	V	VI	VII	VIII
Fissurella volcano juv.	1·6	—	0·8	—	0·8	0·6	1·2	—
Notoacmea paleacea	—	—	—	—	0·4	—	—	31·8
Norrisia norrisi juv.	—	—	3·1	—	0·9	1·3	0·2	—
Tricolia pulloides	—	—	—	3·3	0·4	—	0·2	—
T. rubrilineata	—	36·8	19·2	31·8	40·0	39·7	44·0	2·2
Lacuna unifasciata	—	22·0	64·1	36·1	7·8	50·6	10·6	61·7
Littorina scutulata	—	—	—	—	—	0·6	0·3	2·1
Barleeia californica agg.	—	40·9	5·5	26·0	24·1	1·3	29·1	—
Caecum californicum	88·7	—	—	—	7·1	—	5·0	—
Fartulum hemphilli	—	—	—	—	1·3	—	0·8	—
Mitrella carinata	—	—	4·7	1·6	6·3	4·3	6·7	2·2
Septifer bifurcatus	—	—	1·6	—	—	—	—	—
Philobrya setosa	—	—	—	—	2·8	0·6	1·2	—
Protothaca staminea juv.	4·8	—	—	0·5	2·0	—	0·3	—

I – *Colpomenia,* II – *Egregia,* III – *Halidrys,* IV – *Sargassum,* V – *Corallina,* VI – *Prionitis,* VII – *Gigartina,* VIII – *Phyllospadix.*

TABLE 7

Dominance of mollusc species (as a percentage of those individuals present) on three plant species at the Flood Control Channel, San Diego River (Areas D and E).

	Ulva	*Enteromorpha*	*Zostera*
Notoacmea depicta	—	—	0·12
Tricolia compta	—	—	0·01
Lacuna unifasciata	—	—	0·07
Barleeia subtenuis	95·56	87·09	98·71
Bittium quadrifilatum	2·39	6·72	0·13
Mitrella carinata	—	0·10	0·60
Granulina margaritula	0·71	—	0·27
Haminoea vesicula	—	2·23	—
Acteocina inculta	1·19	3·84	—
Leptopecten latiauratus	0·12	—	0·03

DISCUSSION

The presence of a species of marine plant in a given area is dependent on complex ecological factors including tidal level, nature of the substratum, exposure to wave action and inter-specific competition. A mollusc species is also influenced by such factors but in different ways, and its presence may be subject to considerable variation over the seasons and over a period of years.

The association of some molluscs with marine plants may be of no biological significance in that some species roam over large areas on a variety of substrates.

Alternatively plants may be preferred as a source of food, either directly or more commonly because of the epiphytic algae growing upon them. Plants may afford protection from wave action or desiccation. They may shelter molluscs from predators either structurally or by camouflage. They may provide a suitable substrae for the deposition of spawn.

To assess the relative abundance of a benthic species in different samples of a soft substrate it is necessary to take a known area and depth of bottom material. On relatively impenetrable substrates such as rock the important variable is the surface area. When studying the number of molluscs found on plants, surface area of the plant is the fundamental variable, but it is very difficult to measure. This difficulty is emphasised by the multiplicity of standards used by previous workers, e.g. number per unit wet weight of plant material (Colman, 1940); dry weight (Duffus, 1969); estimated surface area (Hagerman, 1966); area of the bottom (Chapman, 1955); volume (Ohm, 1964); and algal lot* (Warmke and Almodóvar, 1963).

We chose, following Duffus (1969), to take the dry weight of weed as the basis for our numerical data. This makes possible a reliable comparison of numbers of molluscs on the same species of weed at different places or at different times, as long as the growth habit of the plant is reasonably constant. We have tried to eliminate the effects of tidal level and seasonal variation by collecting from a small area at one time. Thus at a particular locality we know how the molluscs were distributed among the plant species in our sample. We have calculated the dominance of each mollusc species on a weed expressed as a percentage of all molluscs present. This reduces the inadequacy of dry weight as a basis for the inter-specific comparison of weeds as a habitat for molluscs.

There are a number of species which are rare in our samples and little information can be derived from these numerical values as they can not be considered significant. Table 6 shows the dominance of the 14 most common mollusc species on the outer coast at La Jolla, compiled from Tables 2, 3 and 4. *Tricolia rubrilineata*, *Lacuna unifasciata*, *Barleeia californica* agg. and *Mitrella carinata* are common on most of the weeds except *Colpomena*. *Caecum californicum* is dominant on *Colpomenia*, at first sight a strange habitat for a species most often obtained from sand and gravel. The bivalve *Philobrya setosa* appears from our results to be restricted to Rhodophyta, and belongs to a family whose members are known to be algal dwellers. Table 7 demonstrates the overwhelming dominance of *Barleeia subtenuis* in the bay environment.

A knowledge of the diets of the molluscs is obviously vital to the interpretation of a study of this kind. Unfortunately there is very little information on this subject. The fact that a mollusc is to be found on a particular plant species is no evidence that it is feeding directly upon the plant. Bivalves obviously are not, as they are filter feeders. *Cerithiopsis* and *Seila* may feed on sponges, *Conus* is carnivorous, and *Odostomia* and *Turbonilla* may be ecto-parasitic on invertebrates. Of the

* "Algal lot" = estimated wet weight.

remaining species in our list, the majority probably feed on plants, microscopic algae or diatoms or organic detritus.

There is no doubt that *Notoacmea insessa* feeds directly upon *Egregia*, as it commonly excavates a depression and may cut right through the stipe. (We have observed *Colisella pelta* (Rathke) feeding on the holdfasts of *Egregia*, but this mollusc was not obtained in our samples.) We have not noticed other plants in our samples to have been eaten by molluscs. To draw further conclusions it would be necessary to examine the gut contents of each species.

The growth form of the plants is an extremely important factor influencing the occurrence of molluscs upon them. *Ulva*, which forms thin detached sheets and *Enteromorpha*, which forms thin hollow tubes, lie on or near the bottom. Among the molluscs occurring on these algae, *Bittium quadrifilatum* and *Acteocina inculta* are shallow burrowing species which we found to be very abundant in the surface layer of sand. *Haminoea vesicula* was found to be breeding at Area E when the sample was taken; its occurrence on *Enteromorpha* was probably incidental as it was also abundant on the sand.

The grass-like weeds *Phyllospadix* and *Zostera* have narrow blades which may be over 1 m in length. They often have rich growths of macroscopic epiphytic algae. The beds of *Zostera* form a unique habitat in the bay environment. The species *Notoacmea depicta*, *Tricolia compta* and *Lacuna unifasciata* were not found in other habitats in the bay. The beds of *Phyllospadix* on the outer coast form the major habitat for *Notoacmea paleacea*. Species such as *Tricolia rubrilineata, Lacuna unifasciata* and *Mitrella carinata* apparently tend to favour the shrub-like algae, and *Barleeia californica* and *B. haliotiphila* were not found on *Phyllospadix*.

Of the shrub-like algae, *Halidrys* has branches up to 1 m in length, with a basal leafy part and vesicles on the finely divided reproductive branches; *Sargassum* has a branched and bushy thallus with vesicles; and *Prionitis* has strong flexible branches which are narow and compressed and up to 0·5 m long. Good numbers of a variety of molluscs occurred on these plants without there being evidence for species specific adaptation, or the influence of disturbing factors reflected by the presence of bottom dwelling or sand dwelling species.

An important factor influencing the occurrence of molluscs was found to be the accumulation of sediment in those plants that are able to trap it. This depends on the form of the plant and the exposure of the situation (Dahl, 1948; Wieser, 1952, 1959; and Hagerman, 1966). Of the plant species included in our study, *Corallina* and *Gigartina* are short and densely tufted and the samples of these algae were always found to contain quantities of sand. The samples of *Colpomenia* also contained sand. This alga forms hemispherical hollow structures on the upper surfaces of boulders, and may become convoluted and punctured near the apex. In this condition sand may be trapped within. Little or no sediment was included with the samples of grass-like or shrub-like plants.

This is the reason for the occurrence of such sand dwelling molluscs as *Caecum californicum*, *Fartulum hemphilli*, *Vitrinella oldroydi* and *Teinostoma supra-*

vallatum in association with some of the plant species. Indeed the sand trapped in the cavity of *Colpomenia* forms such a suitable habitat for *Caecum californicum*, that it is the dominant mollusc species in samples of this plant. Furthermore, the beach sand in the vicinity, and even the sand under boulders is less rich in numbers of *Caecum*, though *C. crebricinctum* (Carpenter) appears to be restricted to the latter habitat at Area A. It must be noted however that Nagle (1968) indicates that a *Caecum* species is found on the leaves of *Zostera* in Massachusetts.

The small to minute size of the majority of individual molluscs obtained from the plant samples was very striking. Most were below 5 mm in maximum dimension and many of the individuals of the most abundant species were below 2 mm also in maximum dimension. In view of the mechanical difficulties we would not expect molluscs to be much larger than the strand of the plant on which they sit, unless attached by a byssus. Individuals larger than 10 mm were only obtained of the species *Norrisia norrisi*, *Haminoea vesicula* and *Leptopecten latiauratus* (attached by a byssus). The adults of *Norrisia* are usually found on brown algae with a broad (>20 mm) thallus, but we have found juveniles on red algae also. Individuals larger than 5 mm were obtained of the species *Notoacmea insessa*, *N. paleacea*, *N. depicta*, *Littorina scutulata*, *Bittium quadrifilatum*, *Seila monterevensis*, *Macron lividus*, *Mitrella carinata* and *Septifer bifurcatus* (attached by a byssus). The shapes of the *Notoacmea* species are beautifully adapted to the plants on which they live. The specific associations of *Notoacmea depicta* with *Zostera* and *N. insessa* with *Egregia* are confirmed by our results. In the case of *N. paleacea* we have found juvenile individuals on *Halidrys* and *Corallina* in addition to *Phyllospadix*. The patelliform species *Fissurella volcano* and *Crepipatella lingulata* were found in our samples solely as juveniles. This was also true of the bivalve *Protothaca staminea*; while the adult is found in sand or gravel around the loose rocks, the juvenile is apparently able to nestle among plants. It is understandable that in the case of species having planktonic larvae a variety of plants may provide a favourable site for settling and early development as the young can find protection coupled with good oxygenation of the water. We conclude that plants may be a good nursery for a variety of mollusca species which as adults lead a different mode of life.

SUMMARY

A quantitative study was made of molluscs associated with marine plants at San Diego, California. At an individual locality the different plant samples were collected from a small area at one time, so that a meaningful picture of the distribution of molluscs between the plants was obtained. On the outer coast *Tricolia rubrilineata*, *Lacuna unifasciata*, *Barleeia californica* (with *B. haliotiphila*) and *Mitrella carinata* were the dominant mollusc species on most plants. In a bay environment *Barleeia subtenuis* was the dominant species.

It is suggested that the observed differences in diversity of molluscs on different plant species are closely related to the growth form of the plants. *Ulva* and

Enteromorpha which lie near the bottom carry bottom dwelling molluscs. *Colpomenia*, *Corallina* and *Gigartina* which can trap sand carry sand dwelling molluscs, particularly *Caecum californicum*. The habitats provided by the shrub-like algae *Halidrys*, *Sargassum* and *Prionitis* do not show this overlap. The grass-like *Zostera* and *Phyllospadix* and the long feather-like *Egregia* each have a specific molluscan associate.

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We wish to thank Dr. George E. Radwin, Curator of Marine Invertebrates, San Diego Museum of Natural History, for allowing us to use the mollusc collection for reference. We also wish to thank Dr. Dwight W. Taylor for his comments on the identification of *Barleeia* spp. We are grateful to Dr. J. D. Taylor, British Museum (Natural History), for his comments on an earlier draft of the manuscript.

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J. Conch. **28**: 55–56 (1973)

REVIEW

Shells by Andreas Feininger and William K. Emerson. Pp. 295, Pls. 175 in colour and monochrome, also illustrations. Thames and Hudson, London, 1972, £7.50.

"Coffee table" books are very much in fashion, and it is only to be expected that shells should form the subject for one or two volumes of the kind, since few subjects are capable of presenting such visual pleasure, and books designed to exploit the beauties of the mollusca rather than to provide instruction and identification have found favour for many years; Swainson's "Exotic Conchology", 1834, is little else, and if the term "coffee table" is inevitably used in reviewing the present volume, it may be pointed out in justification that the expression itself is a very old one.

To handle a book produced apparently almost without regard to cost is in itself a pleasure, and very much more so when it represents the combined work of undoubted masters in two contrasting fields. Although the primary purpose of the book is pictures, the shell world and its various ramifications are described clearly and in some detail by Emerson, who pays his readers the compliment of considering them intelligent. Many of them will undoubtedly have no special training in conchology and although this will be found of no disadvantage, his treatment is far more than merely elementary, and will undoubtedly be useful to the experienced shell collector as well. To serve both ends requires a very good writer.

It is fitting that a photographer of international repute should have contributed to the book. Feininger has for long been famous for his mastery of texture and the representation of strange shapes so that they may be seen with a fresh vision, and shells have provided him with a subject which he has obviously found to his liking. He writes an introduction setting out very clearly what he intends to convey in his photographic studies, and his remarks are such as to stimulate the vision and imagination of anyone likely to feel the wonder that lies in natural objects. He brings a rare degree of perception to the portrayal of shell structures, by stripping away preconceived ideas and encouraging new discovery in many directions which may have become over-familiar to some of us in the past. The photographs are entirely without distortion or trick lighting, but when we look on the central section of a *Terebra* for instance, or the flowery fronds of a *Murex* standing alone, it is as if we saw something quite outside our experience as conchologists. Nothing seems either redundant or deficient and Feininger justly remarks on the constant feeling throughout that the photographs indicate "forms of the sea". The point does indeed come over strongly, though from one point of view it seems a pity that the almost total lack of American interest in non-marine mollusca results once again in a neglect of this half of the subject, although the

equal diversity of shape and pattern might have provided a fascinating contrast to the sea creatures which make up the book. Perhaps another and equal volume may be hoped for (wistfully), so that the survey of the subject may be completed. Meanwhile, the close-up pictures of *Harpa* and *Pecten* are perfectly

"... long and lank and brown
As is the ribbed sea sand".

The text is split up among the pictures in a way which makes browsing through the book a prolonged pleasure. There is a commentary on each shell, and many of the facts put forward may be new even to the experienced collector. The printing both of typescript and of black-and-white and colour reproductions, is of a very high standard indeed. For what it is, the book is far from expensive.

T. E. Crowley

J. Conch. 28: 57 (1973)

EXCHANGES OF PERIODICALS

The Society quite often receives invitations to exchange periodicals with Clubs and learned Societies abroad, and although such courtesy is always appreciated the Society is unable to co-operate. It may be a surprise to some people that the Society has no library, although it was not always so. At one time its collection of books and runs of periodicals was a proud possession and its librarian was a member of the Council. The outbreak of war in 1939 caused the authorities in Manchester, which was the headquarters of the Society in those days, to require the library room for civil defence purposes, at very short notice. The library itself was piled in disorder on the floor of a rather damp cellar at Leeds Museum, and had it not been for the efforts of members Mr. and Mrs. Thurgood, librarians, it would have been totally destroyed. As it was, it deteriorated, and when, seven or eight years later, the Museum was forced to ask for the release of the room they had provided free for so long, the housing of the library became an urgent problem. The Council did all within its power to find alternative accommodation at a price it could afford but could not do so, and mindful that there had been very little pressure from the membership to make the library available to the members, very reluctantly sold off the books and periodicals in 1952, retaining only the Journal stocks of back numbers. These themselves have now been sold.

An advertisement in *The Conchologists' Newsletter* (write to P. E. Negus, 82 Chelsea Gardens, Chelsea Bridge Road, London SW1W 8RQ) may well secure a private exchange of publications.

REVIEW

Sea Shells common to North Carolina, by Hugh J. Porter and Jim Tyler. 131 figs. 36 pp. paperback. November 1971.

There is a large demand for popular works dealing with the seashells of a definite area, and North Carolina has commendably produced such a guide for visitors to the state's beaches. It is nicely produced, with an attractive coloured cover and descriptions, notes on geographical range, etc. etc. of 177 species (129 figured)' being about a quarter of the species reported from North Carolina. There are simple, helpful keys and the illustrations are clear. Irritating mispellings are too frequent but do not detract seriously from the general usefulness.

Free copy obtainable from the Division of Commercial and Sports Fisheries, Department of Natural and Economic Resources, Morehead City, North Carolina 28557, U.S.A.

J. Conch. **28**: 59–60 (1973)

REVIEW

The Mollusca of the arid South-West with an Arizona Check List. By Joseph C. Bequaert and Walter B. Miller. Pp. ix–xvi, 3–271, 6 sketch maps. Paperback. University of Arizona Press, 1973. Price $8.

This attractive production is divided into two parts, namely Part I Zoogeography of south-western nearctic Mollusca, and Part II Annotated check list of Recent Arizona molluscs.

Part I is thoughtful and thought-provoking; the authors call their approach "historical geography", comprising as it does present-day (Recent) and past (fossil) horizontal and vertical ranges of the native genera and species now living in the arid south-west. (Definition of the term "arid south-west" is SW molluscan Province covering SE California (Mohave and Colorado Deserts), a small S corner of Nevada, Arizona, most of New Mexico, a little bit of both Texas and Baja California, north and central Sonora). It is not an ecological study, the materials needed for such are not yet available, and the authors rightly consider a thorough taxonomic knowledge of the local molluscan fauna an essential prerequisite for ecological studies.

The molluscan fauna under consideration is divided into seven groups, by far the largest being endemic species (which the authors prefer to term "precinctive—taxa restricted to a territory with definite boundaries, a precinct"): 82% (190 species, 86 of them in Arizona) of the 234 native species of the area fall within this category. The remaining species include eight circumpolar land snails, mostly occurring at high elevations and in relict colonies; five of these species (*Euconulus fulvus, Deroceras* (— *Agriolimax*) *laeve, Pupilla muscorum, Cochlicopa lubrica* and *Vitrina pellucida*) are familiar British species; the last-mentioned is represented in the south-west by the American subsp. *alaskana* Dall 1905. *Pupilla muscorum* was found in 1970 living above the timberline at 12,100 ft.

The general decline of *Vertigo* spp. in the SW is commented upon and it is suggested that this is due to increasing aridity and intense deforestation of the mountains.

The extraordinary distribution in America of *Deroceras* (— *Agriolimax*) *laeve* is discussed (p. 149); the species is native in Arizona at 4,500–8,000 ft. but at lower elevations occurs only in cultivated areas. *Radix auricularia* is now feral in many places, up to 8,600 ft. elevation, and the three slugs *Limax maximus*, *L. flavus* and *L. valentianus* have all established themselves, the last-mentioned "perhaps in the process of becoming feral".

Comparison is made with Connolly's excellent study (1913) of the Mollusca of SW Africa (the Namib-Kalahari Desert), and the authors conclude (p. 98) that "the wealth of strictly precinctive genera and species proves that extreme aridity, combined with prevailing high temperature, conditions supposedly adverse to

molluscan life, seem to have enhanced rather than deterred evolutionary activity in these animals".

Part II is a detailed check-list of the Recent Mollusca of Arizona, giving also type-localities and synonymy for the 173 species and 46 recognized subspecies. A welcome feature is the care which has been taken to differentiate clearly between (a) live-taken material, (b) "dead" shells of uncertain age, and (c) fossil material.

A map of the area studied, with at least some of the localities indicated on it, would have been of much use, and its absence is regrettable.

The cost seems high for what is, after all, a paperback, albeit such an attractive one, but perhaps, judging by modern standards, it is not so. It is certain to be widely used.

NORA F. McMILLAN

Mollusks

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Overseas members are reminded that all monies due to the Society are payable in sterling.

J. Conch. **28**: 61–74 (1973)

FICTIONAL MOLLUSCA

T. E. Crowley

The Cottage, Church Street, Bampton, Oxford OX8 2NA

(Presidential address, delivered 24 February 1973)

Thought of as the central theme for a work of fiction, the mollusca must be considered an unpromising subject. Nobody as far as I am aware, has moulded a story round the biography of a snail. Animal stories are firm favourites through the years, and a few of them have made great literature, but the animals are almost of necessity mammal, creatures whose thought processes are sufficiently near our own (so we think), for their thoughts to be guessed at by the authors, and whose lives are likely to be sufficiently full of diverse adventures to form the potential for a good tale. A certain amount of anthropomorphism is almost necessary to provide a leaven of involvement for the reader, but it also sets a trap for the unwary author whose public may demand it as a fundamental. An example may be offered in the many books of Ernest Thompson Seton, a man undoubtedly most knowledgeable in matters of natural history. His animals all appear to think like human beings and are each given their own name. This helps the story along, but their inevitable ends according to the Law of Nature leave one sobbing quietly as one shuts the book. The genius of Kipling, although he does not stint to humanise his animals in the Jungle Books and the *Just So Stories*, seems quite to avoid this sentimentality. He displays a considerable knowledge of all that appertains to the animals themselves, and it seems certain that without a considerable perception of this sort, no lastingly successful book of the kind could be written. One author who certainly has it is Jack London, as exemplified in his *White Fang* and even more so in *Jerry of the Isles* and *Michael, Brother of Jerry*. These books are about dogs, but the dogs are made heroes jointly with their owners, so that there is much less tendency for the animals to become humanised; the works are in fact, social documents, making as they do, a bitter attack on such things as the cruel circus training methods of the day.

In *Black Beauty*, 1877, Anna Sewell wrote what has claims to be the most popular work of fiction ever published. It has never been out of print since it was first offered to the public, and is said still to be as popular as ever, even though the social scene it portrays has vanished beyond the memory of even the oldest of us. The authoress seems to have fallen into none of the pits set for the unwary writer, and the surprising (for that era) lack of sentimentality, combined with acute observation and undoubted realism, has no doubt contributed to the lasting qualities of the story.

It would be absurd to imagine that fiction featuring the mollusca could fall into the same class as the works mentioned so far. No one can conceive of the thought processes of any non-mammalian animal, least of all an invertebrate;

nobody that is, with the delightful exception of Lewis Carrol, would attempt to humanise an oyster, and the most eventful life which it would be possible for an octopus to lead would be unlikely to be of general interest.

However, there are, as everyone knows, many stories which feature mollusca as a more or less important accessory to the plot—perhaps more than might be suspected, having regard to the normally featureless lives and lack of enterprise of the average member of that phylum. Storytellers are however, always on the lookout for the unusual, for the purpose of weaving their plots, and there are plenty of unusual features about the world of the mollusca, as we well know, likely to prove of interest in this connection.

Having reached this point, I find that my objectives must be defined a little more closely. Mere references to shells, however important the works in which they occur, I must reject at once; and they are many. Only where a mollusc is a pivotal factor to the book, to an extent that the author needs to know something of the animals themselves, will the work be noticed here, and even then most people will be able to recall examples not mentioned in this note, for it makes no claim whatever to being complete, the examples being chosen quite at random.

Looking back for the earliest shell stories I can find, I come to the conclusion that poetry preceded prose in the literature of every great emergent culture, and poetry, even stories told in rhyme, are outside my terms of reference; they form a separate and distinct subject. I must therefore pass over Homer and his description of Scylla, an undoubted giant octopus, as was the Hydra. Seashells are referred to in the old Viking sagas; Robert Rendall (1960) discusses a saga by Egil Skallagrinson, quoting the 'three silent dogs of the surf swell', alluding to those shells we still call dog-winkles, and stating that the nicknames commonly given to seashells in those days, likening them to farm or domestic animals, are still in use by the Orkney children a thousand years later.

I have not been able to find any work of fiction dating from before the middle of the 19th century in which shells figure at all importantly. In the Age of Reason, science and literature did not mix, and this tradition died very hard, to some extent even surviving the mortal blows administered by Jules Verne. Small things in the 18th century were unimportant things, and the smaller they were, the more you despised them. The mid-19th century however, brought a tremendous upsurge of public interest in matters of natural history, and the kind of book which forms the subject of these notes, begins to appear. The few examples I have chosen vary infinitely in the quality of their writing, positively the only thing that links them is their allusions to the mollusca, but I hope by means of some short critiques to indicate how the various authors have attempted to cope with the purely technical side of their descriptions, involving as they must, matters normally unknown except to the specialist.

One or two of the examples are of course, very widely known; it would be natural to expect that the cephalopoda, if only because of their size, enterprise and frightening aspect, would be favourites among the story writers, and so it has proved. The oldest example I am going to take is perhaps also the most famous

incident in fiction involving a mollusc, namely that described in *Toilers of the Sea*, written in 1865 by Victor Hugo. This describes the epic struggle of the seaman Gilliatt with a giant octopus which comes on him in a cave in the Douvres, an isolated rocky island some miles off Guernsey. Hugo is not much read these days, and although he is assuredly a master of fiction he will not hesitate to arrest the action of the story to insert comments and explanations of his own, a practice liable to lay him open to criticism not only from those who want to get on with the yarn, but from the experts whose provinces he is in part usurping. A graphic description of a great storm is preceded by an essay on the incidence of storms in general, and a mere page after the opening of the book finds him launched on a catalogue of the various devils which the Islanders of the day (late 1820s), believed, or might have believed in. Nevertheless, when he gets down to business, his style is graphic, staccato and even highly coloured, probably quite in accordance with the usual French style of story writing of his time. One must of course, beware of commenting over much about style when one reads a mere translation, and a number of Hugo's quasi-technical terms must have provided quite a puzzle to his translator.

The scene on the Douvres is that of a shipwreck. The only steam paddle boat in the Islands has been deliberately driven on the rocks by its captain for purposes of his own, and Gilliatt has set himself the task of salvaging the valuable engines and incidentally, the sanity of the owner. Now a master of fiction may be skilled in describing all that pertains to the human emotions, he may be deeply perceptive in all that concerns humanity, but this does not necessarily mean that he has a ready grasp of such technical details as are needed to describe a major operation on a large piece of machinery, nor indeed, the natural history of the octopods, both matters normally rather outside the experience of literary men much before the time of Verne or Kipling; and an engineer will perhaps remain somewhat unconvinced that the steam engines, complete with boiler and paddles, of a passenger and cattle carrying steamboat, could be detached and lowered into a fishing smack by one man, equipped only with a hammer and an ancient saw, which he sharpened with files made on the spot in a crude forge which he was able to contrive. The work took Gilliatt about two months, for most of which period he lived on limpets and rainwater, and it was toward the end of his self-appointed task that in exploring the sea caves for food, he encountered the octopus. It seems probable that Hugo relied for his copious circumstantial detail on information obtained in conversation, and no doubt there were plenty of sailors and fishermen in St. Peter Port where he lived, who were well acquainted with both steam engines and octopuses. The knowledge so gained must necessarily be superficial however, and this fact can be concealed only if the writer determines to avoid technicalities. This was not Hugo's way, and probably he was right after all, for few indeed of his gentle readers would have known sufficient to see any flaws in his argument. For instance, in describing the caves he says that they contained ". . . some of the rarest *bijoux* of the casket of the Ocean; ivory shells, strombi, purple-fish, univalves, struthiolaires, turriculated cerites".

As a conchologist, this leaves one in a speculative mood. Similarly, when once the dread octopus has been flushed, so to speak, Hugo devotes a whole chapter to describing the horrors of the devil-fishes in general and this one in particular.

It is evident that he is quite correctly writing about *Octopus vulgaris*, common in the Channel Islands, since he describes the arms as having a double row of suckers. The arms are additionally referred to as "feelers" and "antennae", and the animal itself is variously stigmatised as the "sea vampire", kraken, poulpe (inevitably), polyp, pieuvre (a local name), and when in scientific mood, a Cephaloptera, a term of which he seems to have been fond. Where he obtained it is indeed a matter for speculation; it appears to mean "wing-headed" and I find that it is in fact the name of a South American family of umbrella-birds. Hugo speculates whether an octopus can sink a ship, and quotes supposed cases where it has killed unwary seamen.

Plunging in more deeply, Hugo calls it part fish, part reptile; it has no blood, no bones, no flesh—he twice denies it even a beak; but passing by all the criticism, there is little doubt that he was writing of what he had seen, and his description of the incident is powerful and most effectively written. When he calls it a "sombre demon of the water . . . watching with sinister patience in the dusk", one begins to understand the repulsion in which the bulk of humanity holds such creatures, their arms "supple as leather, tough as steel, cold as night".

It is of interest to know just how large Hugo visualises his octopus. Frank W. Lane (1957) states that the arms of *O. vulgaris* attain a length of four feet. Hugo describes ". . . a greyish form which undulates in the water. It is of the thickness of a man's arm and in length nearly five feet . . . Its form resembles an umbrella closed . . . the irregular mass advances . . . suddenly it opens and eight radii issue abruptly . . . they resemble when opened the spokes of a wheel, of four or five feet in diameter". Now this does not make sense unless for the word "diameter" one substitutes "radius". Arms measuring a little under five feet each would give the animal a good ten feet across, and this seems to be what was intended; in fact, apart from a slight pardonable exaggeration, the beast described is by no means beyond reason.

The end of Gilliatt's struggle is predictable; he has his knife, and after trying in vain to cut through the arms, he seizes the critical moment when the poulp reaches forward to engulf him, and cuts off its head with one desperate slash. The body drops away and the seaman falls back fainting; but there is no anti-climax, for the next moment he comes across the skeleton of the captain of the wrecked ship, picked clean by the octopus, and piled high with empty crab shells. "The green mould of the sea had settled round the sockets of the eyes. Limpets had left their slime upon the bony nostrils". Limpets with slime glands might well be a horror even rarer than the giant octopus.

Henry Lee (1875) closely analyses the tale, pointing out that Hugo had evidently spent some time watching octopuses and describes their activities well, at the same time appearing to understand little of what he saw. The arms for instance, are never used for constriction or suffocation, nor can their suckers

puncture the skin nor cause blood to flow. The octopus is incapable of inhaling its victim or sucking it dry; and so on.

One more word from Victor Hugo concerning his devil-fish and then we must leave him. He describes it as having "an aspect like gangrened or scabrous flesh. It is a monstrous embodiment of disease". This book can be confidently recommended to all octopus haters.

Re-reading *Twenty Thousand Leagues under the Sea* (1870) brought to me a realisation that a part of Jules Verne's magic results from his attention to detail. He has a continuing and well deserved reputation as the man who forecasted most of the marvels of modern science and got most of his forecasts right; and this he could not have done without a mind which was capable of dealing with a wide variety of small associated facts. The subject hardly mattered—Verne could write technically on anything. Occasionally of course, he slipped up, but this merely serves to add to the delight of his devoted readership. Chapter 18 is concerned with the fight between the submarine *Nautilus* and a number of terrifying cephalopods which Verne (or his translator: probably both) call Poulps. I confess I have never properly understood the meaning of this word, although its connotations of horror and disgust are undoubted. My dictionary calls it "an octopus or other cephalopod", which is about what I should have said anyway. A character in the book points out "caverns for poulps: 'What!' said Conseil '. . . real cuttlefish of the cephalopod class?' 'No,' I said 'Poulps of huge dimensions' ". Here at least, the octopus seems to be in mind. On the next page, Verne quotes the well documented encounter of the despatch boat *Alector* with a monstrous cuttlefish off Teneriffe. He says they proposed to name this poulp "Bouguer's Cuttlefish", which seems to indicate that it was not thought to be an octopus. One of the crew however, looking at a shape through the observation window remarks " 'Its head . . . was it not crowned with eight tentacles that beat the water like a nest of serpents?' 'Precisely' " is the answer. In other words—an octopod. All this is very confusing. When the great fight is described, the creatures are called poulps or cuttlefish indiscriminately and the vivid descriptions of their beaks, radulae, tentacles (with 250 air holes), spindle-like bodies weighing 4,000–5,000 lbs., the changing colours etc., do not really take one much farther in determining what Verne had in mind, nor is his account of size very clear in spite of the fact that his homework seems to have been thoroughly done. He quotes the legendary encounters with sea monsters by Olaus Magnus, the Bishop of Nidros, Pontoppidan and other people well known in sea legend (all detailed in Gould, 1930), but it is difficult to understand his references to skeletons of poulps in the museums of Trieste and Montpelier measuring two yards in length. Aristotle, according to one of his characters, and they are all unusually erudite, stated the dimensions of a giant cuttlefish as five cubits, that is, nine feet two inches; it is presumed this means the body length. "Bouguer's cuttlefish", similar to those attacking the *Nautilus*, was described as measuring "about six yards". He insists that they have eight arms.

It is perhaps a good thing to blur the edges when you are dealing with the

unknown in fiction; a too-substantial ghost for instance, may lessen conviction. In spite of his vagueness it is quite evident that Verne must have been at pains to verify his facts in writing even this one chapter, since most of what he says is by no means general knowledge. Most people know that cephalopods are capable of producing ink, but few could say much about the blood of a cuttlefish, nor are they likely to know that it has a triple heart. In one or two places elsewhere in the book Verne's catalogue descriptions of fish do give one the feeling that he may have lifted them almost en bloc from a text book. Before his day the literary art was regarded as involving almost exclusively the interplay of personalities and the reaction of human beings to human situations; his stories dealt successfully with things as well as people.

With Verne, as with Hugo and most other writers then and since, supposed extreme ugliness was always equated with an implacable malevolence. The fact that the cephalopoda are essentially of an extremely shy and retiring disposition is ignored, since to acknowledge it would quite spoil the story.

Perhaps the 19th century novel which most of all concerns itself with the mollusca is *The Glory of the Sea* by "Darley Dale". Dance (1956) stigmatises this book as "of indifferent merit" and it may well be so, although this is the fate of all Victorian novels which do not thereafter become classics. The authoress "Darley Dale" was revealed after some research by Tomlin (1936) as Fanny Maria Steele, 1848–1931, descendant of Sir Richard Steele, and a prolific writer.

The volume is undated, but evidence suggests that 1887 was the year of publication. The plot concerns the acquisition by an invalid girl of a fine shell collection bequeathed by a favourite aunt under the secret condition that if she is moved to study the subject and adds to the collection, she shall inherit an extremely large legacy on attaining her twenty-first birthday. Pater Familias is the rector of a country parish and the hero is a young man lodging in the house who is being tutored for ordination. As it happens, this young man knows a good deal about natural history, and his talks on conchology given to the maiden, and which occupy a good half of the book, reveal an erudition which would easily have justified his transportation to Botany Bay. In point of fact, he lectures her as though she were the Royal Society, and she, presumably because the love interest has already made its presence felt, digests the lot without more ado, including the detailed statistics. The story, proceeding on its irresolute way, reveals the loss of the most valuable specimen in the collection, which is naturally a *Conus gloriamaris*, and when this turns up just before the fateful birthday it is revealed that the rector, subject to many anxieties, has been sleepwalking, and has hidden it amongst his private papers. He had been overdoing things in more ways than one, since his wife caught him in the act of hiding a mere *Argonauta*. The novel is a rather extreme example of the Victorian habit of mixing instruction, wherever possible, with entertainment—so much more practical and sensible a principle than the present attempts to dilute education with a superfluity of amusement. At the same time, it is hardly possible to learn much about shells by reading their names, pedigrees and statistics in a book without any illustrations save a few

colophons, and the number of people converted to conchology by this story must have been very few.

"Darley Dale" like many other conchologists—if such she were—had no use for anything nonmarine; the characters in her book unite with enthusiasm in their loathing of slugs. Land snails are dismissed with a mere allusion or two except in one place where *Achatina* is briefly mentioned.

Tomlin considered that the plot was probably suggested by a previous one-time best seller called *Sylvester Sound*, but Marjorie Fogan (in litt.) justly points out that it is more likely to have been a crib from Wilkie Collins' classic *The Moonstone,* 1868, which was probably the first thriller to employ somnambulism as the centre of a plot involving the disappearance of a valuable object. *The Glory of the Sea* is a rare book these days, but part of the difficulty in finding it in the secondhand shops probably stems from the bookseller's indecision whether to put it among the novels or on the natural history shelves.

S. Baring-Gould wrote many stories about the people who lived on the inhospitable borders of Dartmoor. There is little in the way of a plot about these stories—they consist almost entirely of vignettes of the life of what a hundred years ago might have been described as "peasants". One may justly call them "short and simple annals of the poor". However, they bear every mark of authenticity and give vivid and obviously accurate pictures of things as they then were. A number of these stories was collected by Methuens into *Dartmoor Idylls,* 1896, and one of them, entitled *Snaily House* claims our attention in the present connection. The tale is concerned with twin girls who are sent to live with the survivor of two old aunts who dwelt in a remote house on the edge of the moor. It had long been noticed by neighbours that the old women had no visitors and made no shopping expeditions, and the local gossips could only imagine that they lived on snails and slugs which they pickled themselves. Concern is felt for the twins that they might be forced to live on a similar diet. "Snaily House" was in fact not the name of the dwelling but merely the nickname given to it by the neighbours.

Remembering Baring-Gould's meticulous attention to detail, one might infer a local legend about people living entirely on snails, and so thought A. E. Boycott (1933) who looked into the matter. He was able to find a spot on the $\frac{1}{2}$in. Bartholomew map marked "Snaily House" which lay at an altitude of nearly a thousand feet by the East Dart, a mile and a half below Postbridge. Although he does not allude to Baring-Gould's story, this must surely have been written round this very house, and Boycott mentions a similar tale entitled *The Outlandish Ladies* written by Quiller Couch. This spurred Boycott to make local enquiries and on three separate occasions he was told of the two old women living at "Snaily House" and subsisting entirely on mollusca. He gives an account of the snails he found in the immediate locality, commenting that they did not include *Helix aspersa* but adding fairly enough that the legend was an old one, things might have been different in the 18th century, and *aspersa* still lives in Postbridge. The garden snail might well have lived at "Snaily House", as it does in other unlikely places

such as on the Malvern Hills, under circumstances of cultivation. When Boycott visited the old house, there certainly seemed little about it which could have merited its strange title, which seems therefore to have sprung from the legend, another version of which suggests the indignation of the moormen on the regular disappearance of sheep, suspicion of theft falling on the old ladies, and an angry march to the house to uncover their dishonesty revealing nothing but the tubs of pickled mollusca. Certainly there seem several cases on record where snails have provided the last refuge of the destitute, as of the seriously ill.

The Shell Hunters by Gordon Stables, is what used to be called a stirring (or was it a "rollicking"?) yarn for boys, and being both a physician and a naval officer, the author must be deemed to know a fair amount about his subject, involving as it does, zoology and the sea. The book appears to have been written about 1901–3, and the related visit to the Phillipines evidently happened before the end of Spanish rule there, since Stables has some highly critical remarks to make about the administration; this would be prior to 1899.

The tale concerns two youths, cousins, living in Scotland where the father of one of them is a renowned freshwater pearl fisher. Where ordinary men had to kill a hundred river mussels to obtain one pearl, it was said that he could find treasure in one out of twenty-five. No doubt he could have given many hints on conservation to the tinkers who still uselessly destroy the remaining beds of these interesting creatures. The gripping part of the yarn, for the less sophisticated among us at any rate, commences when the boys get lost on the Cairngorms. When at the end of their tether they are startled at the crucial-moment appearance of a sea captain who leads them into a remote but remarkably well appointed cave in which, for no particular reason, he happened to be living at the time. He proves to be the owner of a brig due to sail on a shell hunting expedition, and in a trice the boys, having nothing else to do for a few months, agree to go along as privileged passengers. In addition, since room seems to be at a discount on board, they are joined by the young sister of one of them, who proves like many heroines of her generation to be a strange mixture of tomboy and clinging vine. The Newfoundland dog came too.

The ship is described as well equipped for shell hunting, the necessities including such things as a large diving bell. The first destination is Mauritius, where are found "some of the finest shells ever brought to light". Unfortunately there are some baddies also hoarding rare shells; however, fresh specimens of *Strombus* make the most terrible of knuckledusters and the captain carefully chooses a *gigas* and a *latissimus* to ensure the victory. Perhaps this might be a point worth remembering when it comes to reviewing the commercial applications of the mollusca.

Diving for shells with air line equipment is described in light hearted detail, but we are carefully told that the large majority of shells so gathered were thrown over the side again while still alive, being adjudged commercially worthless. Apart from the embryo idea of conservation, no doubt the accommodation on board even that ship had its limits, and we infer that the main quest of

shell expeditions must at all times have been for the rareties. The story must surely owe something to the annals of Cuming.

It was not only marine mollusca which interested the party. A forest shell was described, "one of scores", which looked as though it had marked on it words or mottoes in English or Spanish, traced in purple ink. "The curiosity was very large and smoothly domed. There seemed upon it a map of South America and distinctly enough, the words Peru and Lima". The reader is left to speculate if the shell markings were natural or embellished by the human hand, but the specimen must indeed have been an unusual one. The only species which could begin to fit the description is the agate snail, *Achatina fulica*, which had already invaded Mauritius by the turn of the century.

In search of further shells, and incidentally of a long-lost wife, the brig sets sail for the Phillipines. For the maiden at sea, the days are enlivened by surface trawling—though it says "... dredged—a whole boxful of the very tiniest but most beautiful shells of at least one hundred species, some not larger than a grain of canary seed—but that she had mounted on black squares of cardboard ... one of the prettiest collections of almost microscopic shells. . . ." One infers pteropods although Stables is somewhat shy of overloading his readers with technical terms. Effie's abysmal methods are in alignment with those used at the British Museum at that time. There is no indication whether she had any means of identifying the species, nor how the shells were packed for transport home. Comments are made on the tendency of tropical shells to lose their colour, but a little exaggeration is surely to be found in the remark "Knowing that the bright colours of these would fade and fade until they were no handsomer nor prettier than the colourless shapes to be found in old museums, Paul did his best to colour one of each species, and it must be confessed that his attempts were pretty successful. No, not quite. Malacology is but in its infancy and good tinting has yet to be learned. . . . I do not say so to discourage shell hunting but rather to stimulate collectors to study the arts of delicate colouring and staining". Surely an illuminating comment on the contemporary attitude to malacology, and on the Victorian misconception that Nature couldn't manage to struggle on without the help of Art.

No book of this sort would be complete without its octopus incident, and a great encounter of the sort is duly recounted, resulting in the unfortunate death of one of a series of rather expendable cabin boys.

However ramshackle his plot, Stables gives the impression that he knows his shells very reasonably well but thinks it necessary to water down the scientific draught by a considerable degree to make it potable for young readers. Perhaps he read Darley Dale's masterpiece, and resolving not to fall into the same trap, overcompensated by removing a lot of the interest in the subject which might otherwise reasonably have been incorporated into the tale.

The first half of this century seems to have been rather lacking in shell stories, and the mollusca where they occur play a purely subsidiary part. Examples of what I mean occur in the "Dr Thorndyke" series by R. Austin Freeman, in two

of which the mystery is solved by the presence of the appropriate snails; one of the cases concerns a rare species of pond snail found on the body of a drowned man, the point being that the snail lived in one lake only, which was not the one in which the corpse was found.

The poison bite of the Cone shells is another tempting focus for a plot, and was so employed in a mystery story, I believe by Ian Fleming, although I have not read it; but coming to more recent years, one finds a tale with a highly scientific background, *The Deep Range* by Arthur C. Clarke, 1968, telling of animals from the deeps in the years to come when whales will perhaps be herded and cared for as cows are today, but with the help of electronic curtains and one-man submarines. At one point in the narrative, mysterious losses of whales are traced to an exceptionally large squid which, not content with refusing to share the customary fate of his kind in becoming whale-meat, is turning the tables on even the largest cetaceans and eating all of them which come his way. In deciding that this state of affairs must stop, the Bureau of Whales, World Food Organisation believes that it might be possible with the aid of narcotic guns to capture the squid alive, and the difficulties and dangers involved in carrying through the project are convincingly described. In fact, the whole book forecasts quite graphically the possible position which might be reached in the conquest of the deep seas within the next hundred or two years. From the viewpoint of these notes however, not much malacological detail is attempted.

Darley Dale's work is high drama compared with a short story entitled *The Gasteropod* by Maggie Ross (1968), which was the subject of the shortest review ever known when A. E. Ellis (Conchologists' Newsletter no. 33) wrote of it: "This is not a conchological treatise". I find nothing misleading in this summation. There does not seem to be any reason for the archaic spelling of the title but the story itself consists mainly of the meditations of a gentleman with little else to do, who spends his time recording with diary and camera in a most methodical fashion, the progress of the love affair between his wife and his best "friend". The principal character (one cannot describe him as the hero), is represented as a collector of tropical shells, and I am sure that it can be said with confidence that there is no one like him in this Society. His collection is supposed to be symptomatic of his careful and scientific outlook on the World, and various references to it suggest that Miss Ross had access to advice from a collector although certainly not from a scientist, for on the very first page, this toad-like character is described as preserving his specimens with varnish. His last and most longed for acquisition is a left-handed chank, which is fair enough, since India has a virtual monopoly of them for religious purposes. Of the shells in his possession however, he counts two hundred pounds as the cost of a decent *Murex tenuispina*, which seems in itself to throw doubts upon his claim to be a careful man; and in any case would a careful man be likely to wear a suit the colour of a green abalone?

The collection it seems, includes *Murex lobeckii,* a fact which might bring into question the collector's integrity: however, perhaps it was just one of the shell

forgeries which he is described as making for his own amusement. *Conus gloria-maris* is reported present, as is *Clytospira* (sic), and both receive due adulation. Few of the popular shell legends but receive their dusting off—somebody's father for instance, was killed by a *Conus geographus* although the specimen was, regrettably, not in the collection.

Our conchologist does occasionally comb the seashore and pick up his own shells, and it seems that his favourites are the Solenidae, for he alludes more than once to the methods employed in capturing them alive. Each is then labelled with its common as well as its scientific name. Always, he says, he tries to improve on nature; the gloss must be heightened, and all chipping removed with a fine rasp. His room is full of acid bottles, vats and jars, burners and magnifiers, in cupboards and on shelves of his own making, and it all sounds extremely methodical and quite 19th century.

Conchologically speaking, *Blank Claveringi* by Patricia Highsmith (1951) is a better story and this too has been noticed by Ellis (1972). It represents a quite effective variation on the legends of the Giant Gooseberry. In this instance, Professor Clavering of California (where else?), is desirous of discovering a new species of something (almost anything would do; hence the cunning of the title), so that he might win immortality by conferring his name upon it. Here, Miss Highsmith's taxonomy seems less efficient than her fieldwork, since no scientist would consider doing such a thing for a moment. Doubtless it would be possible for a bounder to bribe a colleague in the matter, but what a pity the authoress slips up by invariably giving a capital letter to the trivial names.

The story is well worked out. The professor gets in touch with a man in Hawaii who recounts his search for a legendary snail with a shell diameter of the order of fifteen feet, said to live on an island three miles by one, not far away. The man does not believe in it himself, having spent a third of his life in search of it, which indeed seems more than enough for the examination of a small island. Nor can he have been a skilled field worker since the professor, who was obviously made of sterner stuff, on reaching the island, observes at once the depredations of some elephantine animal in the uprooted bushes and broken branches all around him, and is able to locate the snails within minutes. These creatures amply fulfil the legends told about them, and one gathers that their efforts in sustaining themselves in their cramped quarters are only partially successful. In other words the magnificant snails, as the reader might fully suspect, are extremely hungry. Having chewed up the mooring ropes of the professor's boat while his back was turned, they proceed to harry him all over the island with a languid but menacing persistence which is most graphically portrayed and suggests that the authoress must have spent some time snail watching. Anyone having any acquaintance with her stories will readily forecast the end of this one, but there is some substance in the professor's idea that the name of the molluscan genus he is investigating should be *Carnivora*. The good man had an axe with which he ineffectively tried to defend himself, but it would have been most interesting to hear what in Miss

Highsmith's opinion, might have happened had he been able to sever the snail's tentacles with it.

The tale is worth a couple of good illustrations, and it does stimulate speculation about size limits for shelled mollusca. Functional sizes for insects are sharply confined but those for snails rather less so. *Achatina achatina* is much the largest living landsnail and its shell is, in round figures, a foot long. It is a highly successful species and other genera, living or fossil, might reasonably be expected to reach a similar or greater size. They apparently do not, and this suggests that *A. achatina* is a specialised type. It is possible that with increasing bulk the molluscan speed capabilities are insufficient for providing a reliable feeding range. If natural selection were to increase the speed of landsnails, which it seems it has no tendency to do, there seems no reason why they should not increase in size. No doubt there are many other factors which would in fact restrict them, and possibly some of these have already been called into play.

Considering that they are tales of unabashed fantasy, Miss Highsmith's snail events bear a pleasing veneer of credibility, and it appears that, to quote a recent T.V. programme, she lives in France "with a pet snail" (species not mentioned), so that one may infer that she has perhaps more than a novelist's interest in malacology. Certainly her writing indicates that she has spent a good deal of time in close observation of snaily habits; their intimate moments are accurately described in another of her short stories, *The Snail Watcher*, 1970. The enthusiastic snail breeder who forms the central character faces a dilemma when his study becomes completely full of jars, tanks and vivaria. His snails produce young at an ever increasing rate until they finally take over the whole room, and, on entering after an absence of a few days, the luckless conchologist is predictably overwhelmed by his hobby and, like most of Miss Highsmith's heroes, is seen no more. Not very convincing at breakfast time, but a nasty dream nevertheless, owing something to H. G. Wells perhaps, but without the unexpected cunning twist that marked the master.

The Old Shell Collector by H. R. F. Keating is a short story which offers the theory that a habit of detailed observation and deduction acquired in one field may be found of use in a completely different direction. The scene is a seaside resort and on the edge of the beach is a rather dusty and old fashioned shell museum supervised by Mr. Pedicle (a good invertebrate name),—a cripple in a wheel chair. Visitors are few, and he spends his time at the pay-desk endlessly sorting local shells, brought to him for a small payment by the children, in a search for varieties. He observes most of what goes on outside and in particular, the antics of an ill-bred crowd of adolescents making nuisances of themselves on the beach. When, after a day or two, one of them is found dead and the others, considerably chastened, are driven into his museum by a thundery shower, he is able, by having observed them and listened to their conversation, to deduce that one of them is the murderer. Having run up his locally well-known red flag for attention, he explains to the sneering youngsters that the shells they so despise are not the useless junk they have loudly called them, but objects

most useful in developing the human mind. By the time he has got to his point and revealed the murderer, the heavy tread of the constable is heard on the steps outside and he is relieved of his responsibilities in the matter. There is not a great deal of shell description in the story itself, about as much as would be written by an author who had spent an hour in a shell shop; several specimens are briefly described and given their common names, but the museum is described authentically enough, and most of us have visited similar places. Reverting to the argument however, I have myself never been able to establish in my mind that a highly methodical attitude in dealing with a facet of natural science has reflected itself in methodical habits anywhere else. Many scientists seem to me to live their personal lives in a dreadful muddle, more or less, even in the office where they do their work, and I have yet to hear that observation and deduction in zoological matters produces, however incidentally, a talent in criminal investigation.

Are there any deductions to be made from these notes? In view of the great variation in quality and type of the stories dealt with, and the superficial nature of the review, probably not. The choice was a random one and the reader can no doubt think of other and better stories for himself. Only two points seem to arise; one concerns the great difficulties which face the novelist in embarking, for general consumption, on a story concerned with a highly technical subject; unless he is as much of a conchologist as a writer, for instance, he can hardly avoid dropping bricks in dealing with shells, and it is better for him to skirt warily round the edge. At the same time he may justly reply that if the general reader sees nothing amiss, all is well. The problem of just how authentic to make one's writing is solved in an infinite number of ways and certainly depends on how technical one's readership is expected to be; anachronisms in a historical novel these days are unforgiven. Some fiction is great literature and much is forgiven it; some is petty, potboiling stuff and inaccuracies matter little. What would you have?

The other point concerns the novelists' opinions about conchologists. Perhaps the less said here the better. We must be a very odd lot and I have no doubt that this is an unchanging image.

In closing, I should like to express my gratitude to Mrs. Marjorie Fogan and Mrs. Alice Wilkins for helpful suggestions and for the loan of books, which these days is the ultimate mark of confidence.

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PROTECTIVE RESEMBLANCES IN BRITISH *LAMELLARIA*

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As long ago as 1893, W. A. Herdman noted that a Manx specimen of *Lamellaria perspicua* (L.) (Gastropoda Prosobranchia) resembled fairly closely the encrusting compound ascidian on which it lived and fed. Herdman identified this ascidian as *Leptoclinum maculatum,* which appears to be a synonym of *Didemnum candidum* Savigny. The mollusc was on a colony of *Didemnum* in Port Erin Bay and lay in a hole which it had eaten out. Its dorsal pallial surface was whitish, with small darker marks, rather closely simulating the appearance of the prey. The mantle also bore two larger elliptical clear marks which, according to Herdman, "looked like the large common cloacal apertures of the Ascidian colony". This was evidently a good case of protective resemblance.

Less well known is the fact that defensive resemblances in lamellariids may be carried one stage further, and many (perhaps all) species of *Lamellaria* are able to secrete from subepidermal acid gland sacs all over the body, strongly acid defensive fluids (Thompson, 1960; 1969), similar to the acidic blood of many ascidians. So the inquisitive fish, grazing over rocks searching for its food, would be unable to distinguish a *Lamellaria* from some ascidians either visually or by taste. Fish are known to detest food which tastes acidic (Bateson, 1890).

Recently, Ghiselin (1964) has drawn attention to the close resemblance existing between the N. American Pacific coast *Lamellaria stearnsi* Dall and the compound ascidian *Trididemnum opacum* (Ritter). The pale colour of the mollusc mantle matches the prey closely, and the outlines of the pallial acid glands resemble the pattern of the oral apertures of the ascidian. Ghiselin has furnished photographic corroboration of this proposed resemblance.

In all these cases the lamellariid appears to have become modified through natural selection so that it resembles visually, chemically and in texture the customary prey-organism.

The purpose of the present note is to describe for the first time lamellariids which have become modified so that they resemble nutritionally irrelevant parts of the littoral substratum. In collections of *Lamellaria* made in the south west of Britain over a period of years, careful attention has been given to the colours and general resemblances they exhibited. The collections fall into three principal categories, and it should be noted that no specimens resembling ascidians have been discovered here. Perhaps this particular kind of resemblance is to be found

chiefly in the more northern waters where Herdman worked. Here are the three categories encountered in Cornwall and Devon:

A. *Lamellaria latens* (Fig. 1)

This small species reaches about 12 mm. in extended length alive, and the colour pattern on the rather smooth mantle is not very variable. The ground colour is pale fawn bearing many small brown spots each of which consists of a black central speck surrounded by a brown ring which is in turn encircled by a band of chalk-white stippling. The whole aspect is drab and, taken together with the flattened body-shape, this makes the animal difficult to detect visually on virtually any hard marine substratum.

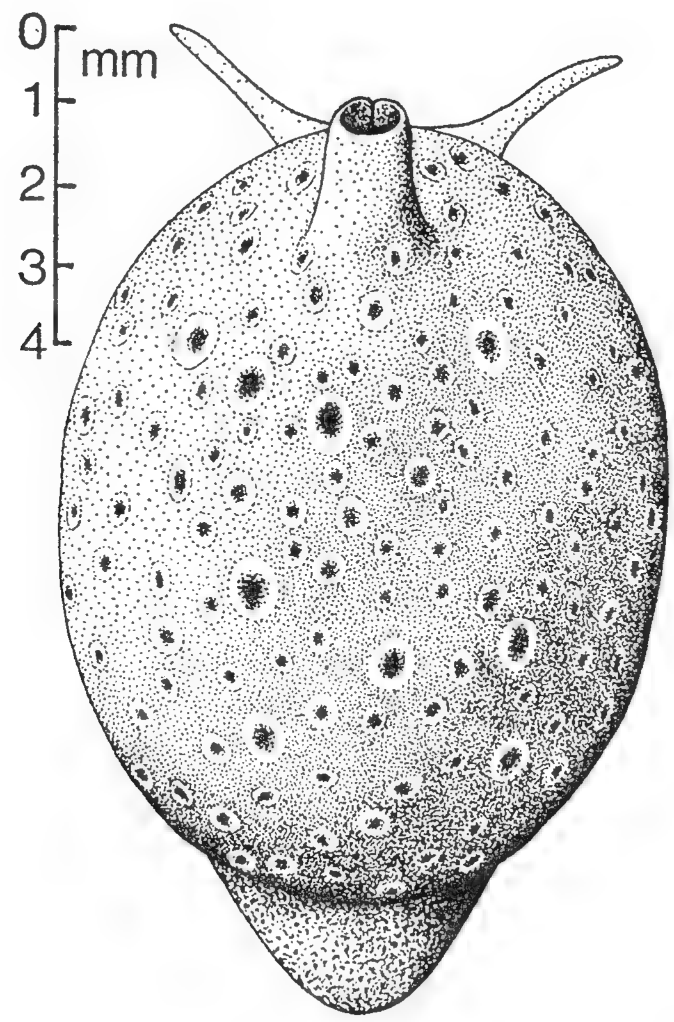

Fig. 1. *Lamellaria latens* from the dorsal aspect; Flushing, Cornwall, April 1969 (drawing by G. H. Brown).

B1. *Lamellaria perspicua* (Fig. 2A)

This species may reach 25–30 mm. in extended length alive and in the variety illustrated the mantle is roughened and bears many low warty tubercles. These tubercles are quite soft and are entirely superficial excrescences composed of the normal acid-secreting epithelium with its associated musculature and connective tissue; there is no local discrete subepidermal skeletal supporting structure of any kind. The colour of the mantle is variable and may include specks of purple, white, yellow, red, and black, rendering the animal hard to detect under most normal circumstances.

B2. *Lamellaria perspicua* (Fig. 2B)

About half the individuals encountered in some collections from shores in Cornwall have markings and pallial excrescences which can only be interpreted as adaptations for protective resemblance to other, conspicuous, types of marine

invertebrates. This is a category of defensive resemblance quite distinct from that described by Herdman and by Ghiselin, where the model is the actual adult prey-organism. In the present instances, some specimens have been found whose mantle may be modified so as to resemble rather closely the apparent texture and colour of the sponge *Hymeniacidon perleve* (Montagu). An even more surprising resemblance was noted in two specimens collected in April 1972 at Helford, Cornwall, in which false barnacle-like excrescences were present on the dorsum. One of these lamellariids is shown in Fig. 2B. The ground colour of the mantle was pale brown and irregular patches of orange and maroon occurred here and there over the tuberculate skin. But on the middle of the back could be seen a small cluster of what in many respects closely resembled acorn barnacles. Moreover they had the form of *intertidal* barnacles, rather than the clean plates and more erect shape of sublittoral balanids. Only with a hand-lens or a microscope is it possible to see enough to suspect that these "barnacles" are false and that the apparent apical aperture in each case results from a well-placed dark central spot of pigment.

The individual depicted in Fig. 2B was sectioned so as to ascertain whether the barnacle-like markings were false or were true crustacean epizoites. The mantle epithelium proved to be normal in every way in stained sections; no skeletal structures were present in the neighbourhood of the observed excrescences and the usual acid-secreting epithelium was continuous over the whole of the dorsum.

It was clear that the barnacle markings are as superficial and illusory as the paint-strokes of a skilled human artist, and are designed solely to create a spurious visual effect.

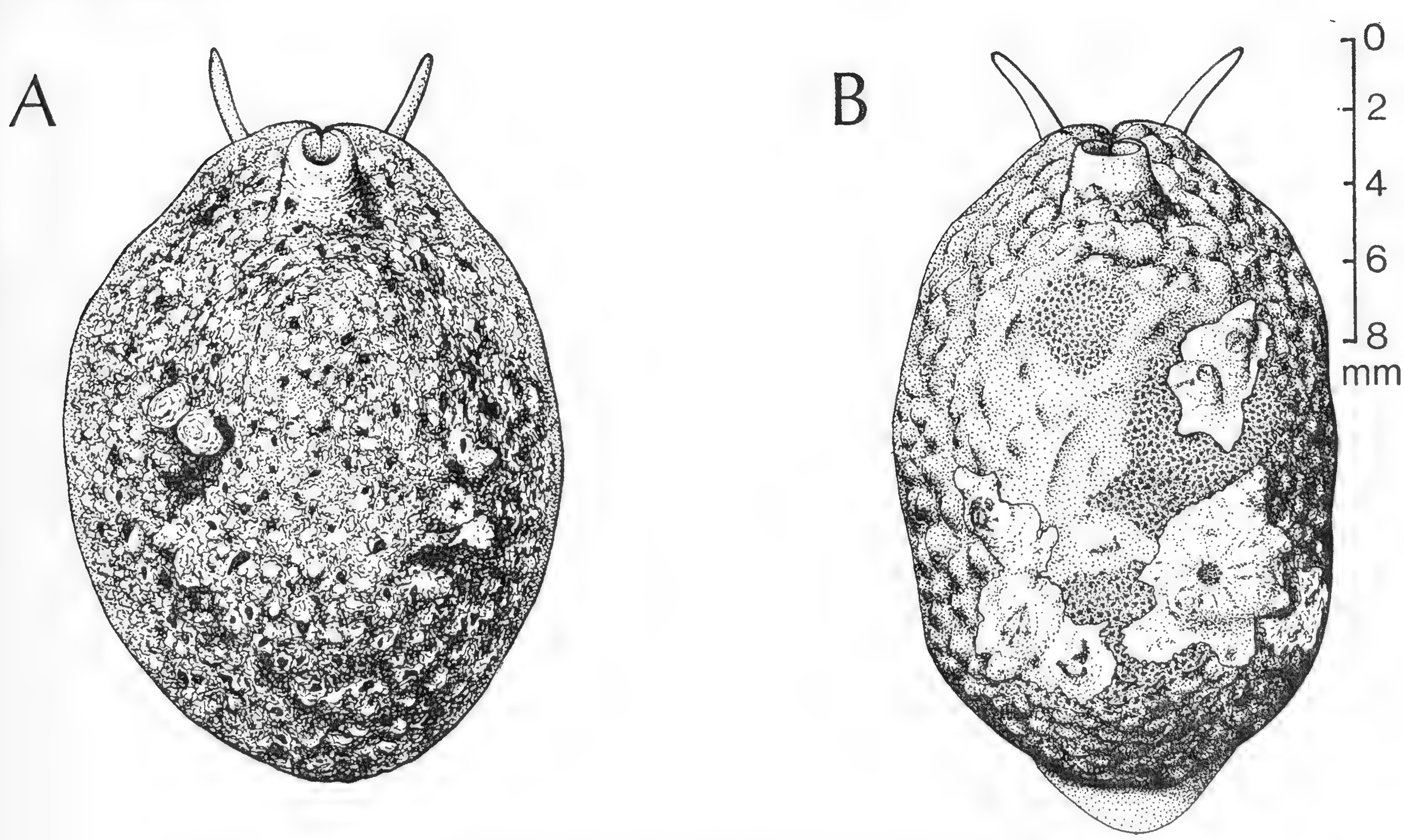

Fig. 2. *Lamellaria perspicua* from the dorsal aspect (drawings by G. H. Brown).
A, Wembury, Devon, November 1970. B, Helford, Cornwall, April 1972.

CONCLUSION

There appear to be four ways in which epifaunal macroscopic marine molluscs may be equipped to elude visual recognition by predators. They may pretend not to exist (as in the tropical planktonic mollusc *Glaucus*, with its counter-shading from the silver under-surface to the dark blue upper surface); they may resemble a generalized piece of the substratum on which they customarily live and move (as in *Lamellaria latens* and Bl *L. perspicua*); they may resemble closely their own specific prey-organism, as in the *Lamellaria* described by Herdman (1893) and Ghiselin (1964); or they may, as shown in the present paper, resemble closely a nutritionally irrelevant invertebrate animal. How far these polymorphic features of *Lamellaria* are phenotypic would be an interesting topic for study, but it is not at present possible to rear large numbers of lamellariids in the laboratory for the trials that would be necessary. The evidence must perforce remain largely anecdotal until success in rearing the young has been achieved.

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J. Conch. **28**: 79–80 (1973)

THE PALAEARCTIC ELEMENT IN LATE QUATERNARY LAKE FAUNAS OF SOUTHERN ETHIOPIA

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Deposits of freshwater shells are found in the vicinity of the lakes Abyata, Langano, Shala and Zwai on the floor of the Rift Valley at an altitude of about 1,600 m. in southern Ethiopia. The deposits are of late Pleistocene/early Holocene age and have been studied recently by Grove and Goudie (1971), who regard the molluscan assemblages as "comparable with those living today in large freshwater lakes in other parts of the African Rift Valley system". This interpretation does not seem to be entirely correct and the purpose of the present note is to draw attention to the palaearctic element by which the molluscan faunas represented in these assemblages may be distinguished from the molluscan fauna of the more southerly part of Africa. Among the four species cited by Grove and Goudie are two, *Melanoides tuberculata* (Müller) and *Anisus natalensis* (Krauss), that have an extensive range in the Ethiopian zoogeographical region, but the others (*Valvata nilotica* Jickeli and *Pisidium moitessierianum* Paladilhe) deserve further discussion.

Shells of *Valvata* from a past bed of Lake Zwai were identified by Bacci (1940) as *V. nilotica scioana* Pollonera, which name may be applied to living populations of *Valvata* that today are apparently confined to highland Ethiopia, being found no lower than Akaki (Mandahl-Barth, 1956), situated about 100 km. north of Lake Zwai at an altitude of about 2,000 m. Ethiopian shells tend to have a longer spire than *V. nilotica nilotica* Jickeli now living in Egypt, or *V. saulcyi* Bourguignat of the Near East and recently found living in the Sinai Peninsula (Tchernov, 1971). All these forms seem closely related to each other and to the European *V. piscinalis* Müller. In Ethiopia the genus *Valvata* reaches its southernmost limit of distribution and accordingly may be regarded as a representative in Africa of the palaearctic fauna. The most southerly locality known is for shells from deposits of radiometric age between 5,800 and 9,700 years BP in the lower Omo river basin, north of Lake Rudolf (Van Damme, 1969).

The identification of *Pisidium moitessierianum* from southern Ethiopia by Grove and Goudie (1971) is the first record for Africa. This bivalve also belongs to the palaearctic fauna and the most southerly localities previously known are in Spain and in Syria (Kuiper, 1972). No living pisidia have been reported from the lakes of the southern Ethiopian Rift Valley, but four species

(*casertanum, kenianum, ovampicum, viridarium*) live in highland areas of the country (Kuiper, 1966). *P. casertanum* and *P. kenianum* have been collected by the author from streams in or near the Rift Valley of southern Ethiopia. Both species are widely distributed in Africa and *casertanum* is cosmopolitan.

An additional and apparently extinct representative of the palaearctic fauna in southern Ethiopia is *Planorbis planorbis parenzani* Bacci, described from a past bed of Lake Zwai and found by Brown (1965) in the bank of a stream near the Bulbulla river in strata that probably belong to the series studied by Grove and Goudie (1971). Similar shells occur in Pleistocene deposits of the Nile in Sudanese Nubia ("*Anisus planorbis*" of Martine, 1968). The Sudanese and Ethiopian shells are related to *P. planorbis philippi* Monterosato, a dwarf form of *Planorbis planorbis* (L.) now inhabiting the Near East and parts of the Mediterranean coast of Africa.

The presence of *Valvata nilotica, Pisidium moitessierianum* and *Planorbis planorbis parenzani* in late Pleistocene/early Holocene lacustrine deposits in southern Ethiopia contributes a palaearctic faunistic element that is lacking from the past and present faunas of lakes situated further south in the Rift Valley system. It is tempting to relate the past occurrence of these molluscs in the southern Ethiopian Rift Valley with a relatively cool climatic period, but the available evidence indicates that the former high levels of tropical lakes were associated with increase in precipitation rather than reduction in evaporation under cooler conditions (Butzer *et al.*, 1972). The extinction of the palaearctic molluscs in the lacustrine habitats under discussion possibly was associated with changes in the chemical composition of the lake waters resulting in unfavourable high levels of alkalinity, which today appear to exclude living molluscs from all of this group of lakes except Lake Zwai.

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SOME MOLLUSCA FROM BORNU PROVINCE, NORTHERN NIGERIA; WITH APPENDIX: STATISTICAL ANALYSES OF TWO SPECIES (*PILA WERNEI* PHILIPPI AND *ASPATHARIA COMPLANATA* JOUSSEAUME)

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SUMMARY

A small collection of Mollusca (nine species) from Bornu Province, Northern Nigeria, is recorded and commented upon, especially possible extensions of range of *Cleopatra cyclostomoides* (Küster 1852) and *Caelatura aegyptiaca* (Cailliaud 1827). Some measurements of random samples of two common species (*Pila wernei* Philippi and *Aspatharia complanata* Jousseaume) have been statistically analysed and the results are presented in the appendix.

INTRODUCTION

Non-marine Mollusca in Bornu Province were collected by one of us (NFMcM) in 1966. Some specimens were obtained by G. E. Connah, M.A., F.S.A., Reader in Archaeology, University of Ibadan, who was then living in the province and who generously handed over his material to us. Mollusca were also obtained from Lake Chad but these will be published separately.

Little seems to have been written about the Mollusca of the province and it has therefore been considered worth publishing these few records.

As fairly large random* samples of two species (*Pila wernei* and *Aspatharia complanata*) were taken JRG was asked to make statistical analyses of both samples to define, if possible, the range of variation within each species.

DESCRIPTION OF THE AREA

Bornu Province occupies the N.E. corner of Nigeria and is bounded on the north by Niger, on the east by Lake Chad and Cameroun. The classic works on

* As all the specimens of *Pila wernei* were collected on the same day over a very limited area of river-bed (the river Obeid), every specimen seen being collected, the sample may be regarded as random although we are aware that it is not a statistically true random sample. Similarly *Aspatharia complanata*; the sample was collected on the same day over a limited area and every specimen was taken.

exploration of the area are of course those of Barth (1849–1855) and Palmer (1936). The country is mainly semi-arid savannah, a vast plain dipping gently towards Lake Chad and is part of the basin of an earlier and greater lake ("Megachad") which at the time of its greatest extent is estimated to have covered some 120,000 square miles. Maidugiri, the largest town, stands on an old shore-line of this greater Lake Chad, now marked by the Bama-Limani-Bongor ridge (Grove, 1959). Within this old shore-line lie extensive levels of a black fertile clay known as the "firki", still subject to annual inundations. Most of the Mollusca were obtained from this area.

Geologically the area is of the Chad formation, a series of freshwater clays and silts of Pleistocene (?Pliocene) age (du Preez & Barber, 1965 : 49) overlain by fixed sands and spreads of gravel.

None of the rivers is really perennial; the Yedseram (or Ngadda) from which a large number of unionids were obtained flows for a few months only and eventually disappears in swamps near Lake Chad. A week at the important archaeological site of Daima (thirty miles S. of Lake Chad and three miles from the Cameroun border) allowed much material to be collected from the river Obeid (or Ebeidji). Unfortunately the river was almost dry when visited and none of the smaller species of Mollusca which one might have expected to find was in fact obtained.

Lake Alo (or Alau) is one of the few permanent water-bodies (apart from L. Chad) in the area and deserves further attention. A single short visit produced only *Lanistes adansoni* Kobelt 1911.

LIST OF SPECIES OBTAINED

GASTROPODA

Cleopatra cyclostomoides (Küster, 1852) var. *tchadiensis* Germain 1908. A single shell, not fresh, agreeing best with var. *tchadiensis,* was picked up on the side of the "tell" site at Daima; the site is on a slight sandy elevation rising out of the surrounding "firki" (which is flooded for some months every year). The shell was presumably floodborne to its position where found, as no specimens of *Cleopatra* were obtained during the course of the excavation. (NFMcM saw the shell being picked up, and has had all the molluscan material from the excavation through her hands.)

It should be pointed out that as the nearby river Obeid flows into Lake Chad (some thirty miles to the north) the shell of *Cleopatra* presumably came from floodings of the river. If this assumption could be substantiated by more material it would form a most interesting extension of range. *C. cyclostomoides* was described by Küster from the Nile valley and this was the only known locality until Germain announced its presence in Lake Chad in 1908. This represents an extremely discontinuous distribution, and it must be assumed that there are intermediate localities although no records of them seem so far to have been published.

var. *tchadiensis*, described as it is from the same locality, Lake Chad, as the

nominate form, which itself is described by Germain as very polymorphic, is certainly not worthy of specific or even subspecific rank.

Pila wernei (Philippi, 1851)

Generally distributed and common; the species was obtained from many localities in the area (i.e. the eastern part of Bornu) and varied little in size, the usual dimensions being about 73 mm. high and 67 mm. diam. A random sample of fifty specimens was taken at Daima from the river Obeid and has been studied by Dr. Green (see appendix).

This, the largest African freshwater gastropod, occurs almost throughout tropical Africa wherever conditions suit it. It does not vary a great deal from place to place except that dwarf forms are occasionally found. It was reported from Bornu by Patterson, but there is no record of its occurrence north of Lake Chad. It is recorded from the Niger by Alderson (1925).

The species was originally described from specimens sent by Parreyss from the White Nile; Philippi named it after the German traveller Werne who in 1841 made an expedition into that region. Other species are somewhat easily confused with *wernei*, but the main point of distinction is the malleated surface; also, the whorls are flattened at the suture, but not channelled. The spire is somewhat elevated, but in these specimens it was invariably eroded. This erosion is normal to *wernei* (Pain, 1961) in comparison with many other species of the genus.

Lanistes (*Meladomus*) *ovum procerus* (von Martens, 1886).

Only obtained twice, a specimen in the river Obeid at Daima and another by the road from Golumba and Jarawa.

A distinctively Ethiopian genus having much the same distribution as *Pila*, to which its anatomy bears a marked resemblance. The body is disposed dextrally in a sinistral, or more correctly "ultradextral" shell. The genus is not found north of Lake Chad although it occurs fairly plentifully in the lake.

L. procerus occurs in lakes and quiet waters, often covered with algae and sometimes much eroded. It constitutes one of the main sources of food for the Open-Bill Stork (*Anastomus lamelligerus* Temminck) which crushes the shells in its excellently adapted bill before ingesting the animal.

L. procerus is well able to withstand desiccation under prolonged drought; it is able to survive in dry river-beds and may be found alive in large numbers in lumps of clay baked to a brick-like consistency.

Lanistes (*Meladomus*) *adansoni* Kobelt 1911

Numerous specimens by the Dar-el-Jimeul Road, S.E. of Bama. Also in Lake Alo (or Alau). A rather variable species which is sometimes found living with marine or brackish-water molluscs under estuarine conditions. It is common in the Congo Basin in clear quiet streams etc. and thence westwards and northwards to the Atlantic coasts.

Limicolaria kambeul (Bruguière 1792)

Frequent about Maidugiri and sold for food in the market there. A typical shell of nine whorls measured 69 mm. high and 30·5 mm. wide.

The distribution of this species ranges over large areas of western central Africa from Senegal to northern Cameroun; Lake Chad represents almost its eastern limit. It is variable in size and colour and has been described a number of times under a variety of names (see Crowley & Pain, 1970). The usual limit of length under favourable conditions is about 85 mm. Three colour forms are prevalent, one with more or less vertical or zigzag stripes, one unicolorous and without markings in life, and one with vertical stripes of dark colour spreading until more or less fused together to cover most of the shell. A collection of 111 shells from a Maidugiri compound proved to contain 108 shells with vertical or zigzag stripes and three so bleached as to be unidentifiable. No unicolorous shells nor those with the "fused" type of colouring mentioned above were obtained anywhere in Bornu.

L. kambeul is found in a subfossil condition in various places substantially further north than the modern distribution area.

BIVALVIA

Aspatharia (*Spathopsis*) *rubens* (Lamarck, 1819)

Abundant in the river Obeid at Daima and in the river Ngadda, S. of Maidugiri.

Aspatharia is almost exclusively an Ethiopian genus but does extend along the valley of the Nile into Lower Egypt. *A. rubens*, although it is found in the Nile Delta, appears to be a predominantly western species, occurring only sparingly in the Congo Basin where it is recorded by Germain from the Lobay River and the Lower Ubangi, but was nowhere encountered by Bequaert (Pilsbry & Bequaert, 1927). It is found rather more frequently at scattered localities in Nigeria and thence northwards. The type locality is Senegal.

The size and almost circular outline of the shell make this species easily identifiable.

Aspatharia (*Spathopsis*) *complanata* (Jousseaume, 1886)

Abundant with *A. rubens* in the river Ngadda at Maidugiri. A random sample of 100 complete specimens was measured and the data submitted to Dr. Green for statistical analysis (see appendix).

The type locality is Fuladugu, river Niger. Exclusively a western Ethiopian species, considered by Pilsbry & Bequaert (1927) to belong to the subgenus *Mutela* proper. It is now thought to be most closely allied to *A.* (*Spathopsis*) *rubens* (Lam.) from which species its quadrilateral outline distinguishes it.

Caelatura sp.

Caelatura sp. was obtained in small numbers from the river Obeid at Daima

and in the river Ngadda at Maidugiri. On conchological characters the Obeid specimens appear referable to *Caelatura aegyptiaca* (Cailliaud, 1827) and those from the Ngadda to *C. juliani bellamyi* (Jousseaume, 1886) but recent work (about to appear elsewhere) on the anatomy of *Caelatura* from Lake Chad suggests that, pending a thorough revision of the anatomical features of the genus, we can only call both lots of material recorded in this paper *Caelatura* sp.

Caelatura, comparatively small in size, is distributed over central and eastern Africa and lives in the entire Nile. Its occurrence in the western parts of equatorial Africa is much rarer and more scattered.

The systematics of the genus present a good deal of difficulty, and the relationships are still far from being elucidated: Bloomer and Mandahl-Barth have treated of the anatomy of some of the species but concluded that dissection has very little value for systematic purposes in this case, and even the glochidia show remarkably little variation. Our knowledge of the ecology and development of the different species, or even of the fish liable to be parasitised, is still rudimentary, and since many specific descriptions are based more than anything on variations in the shape of the shell, it seems likely that some of the species will eventually be relegated to the synonymy. The relationships of *Unio* and *Parreyssia* to *Caelatura* themselves remain to be worked out.

Caelatura aegyptiaca lives principally in the Nile, and if confirmed from the river Obeid, this would represent an extension of range, the nearest record appearing to be from Mokaka, French Congo, by Rochebrune. *C. juliani* is a west African species.

The purpose of this paper was to record the Mollusca taken in 1966 but Dr. Green's statistical analyses of some measurements of two of the species obtained have provided interesting results. Before considering these, however, it is necessary to draw attention to the statement (on p. 83 of this paper) that in *Pila wernei* "the spire is invariably eroded". This suggests that measurements of this species would be inaccurate, but this is not the case. Erosion of the spire in this species does not falsify the whorl count because the erosion takes the form of removal of the periostracum so that the spire looks naked and then a number of small pittings form.

ACKNOWLEDGMENTS

We are grateful to Mr. Pain who cheerfully undertook the tedious task of measuring the samples of *Pila wernei* and *Aspatharia complanata*, and to Dr. C. R. C. Paul and Mr. David Harfield for reading and commenting on the manuscript.

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APPENDIX

We here give statistical information concerning the samples of snails (*Pila wernei*) and mussels (*Aspatharia complanata*). We provide the sort of descriptive data that ought to be on record concerning the distributions of important measurements for any newly-investigated species.

The probability distribution of a dimension measurement is usually represented by a frequency curve which is such that the area under the curve between any two values on the x axis, say a and b ($a < b$), represents the *probability* that the measurement on a randomly sampled specimen lies between a and b. (For example, see fig. 1). The total area under the curve is 1. This probability is also equal to the *proportion* of these specimens out of the whole population which has the dimension between a and b and is approximately equal to the corresponding proportion of a large sample. One type of frequency curve which is often found to be, at least approximately, appropriate for measurement data is called the normal curve (it is also known as the Gaussian curve or the error curve), as illustrated in fig. 1. Data which may be represented by a normal curve is said to be normally distributed. Such a distribution is symmetrical about its mean, is bell-shaped, and possesses two parameters, the mean (central value) and the variance (or, equivalently, the standard deviation, which is the square root of the variance and is in the same units as the measurement). The variance (or standard deviation) is a measure of spread, that is of scatter of values about the mean. Roughly half the distribution lies within ± two-thirds of a standard deviation about the mean (proportion = 0·4950, more accurately), and within ± one, two and three standard deviations the proportions are about two-thirds, 0·95, and nearly all, respectively (more accurately, 0·6826, 0·9545, 0·9973). (Slightly lower proportions obtain if *estimated* values are used for the mean and standard deviation, but the differences are small when a large sample is used.)

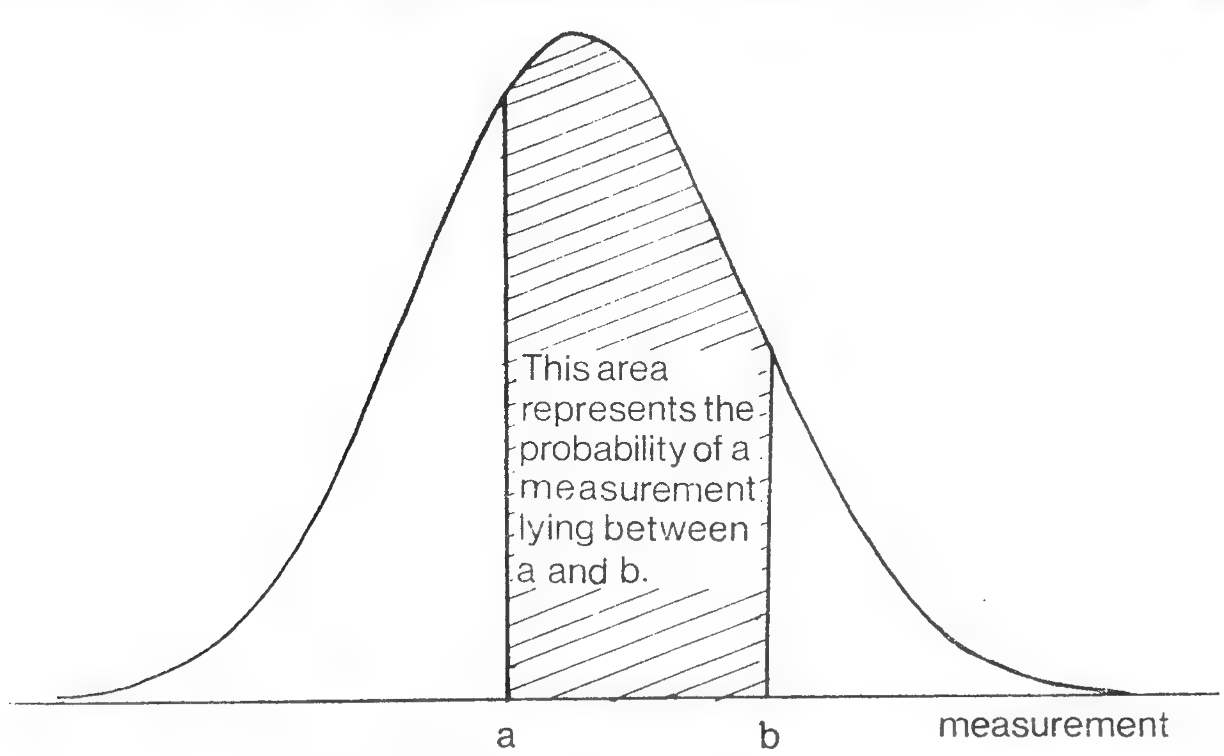

Fig. 1. The normal distribution.

It is usual, when assessing a new source of measurement data from a statistical viewpoint (such an assesment ought always to be carried out to provide a proper, scientific description of the data) to test whether or not the measurements are normally distributed. If they are, then this fact and estimates of the mean and variance should be put on record. The normal distribution is well tabulated and its properties well known, which is convenient for any further study on such data. If the data is not normally distributed, further work can be done to estimate the underlying distribution, or at least a record of estimates of several leading parameters (such as mean, variance, a measure of skewness, and a measure of kurtosis) afford a useful summary of the distribution. A frequently-used method for testing whether or not a given set of data conforms to a normal distribution is to test whether estimates of skewness and kurtosis are significantly different from zero. Skewness is a departure from symmetry wherein one tail is bigger than the other. Kurtosis is a measure of the sharpness of the central maximum (mode) relative to that of the normal distribution with the same variance.

The results of tests of normality on each measurement are shown in table 1; also the quantities, mean, variance, standard deviation, measure of skewness and measure of kurtosis, are here presented for each type of measurement considered. These measures are calculated from the samples, which are reasonably large, and sufficiently so for these statistics to provide good estimators of the corresponding distribution parameters (that is, the values which would be obtained if we used the *whole* populations of such measurements). The formulae used are as follows:

Considering any one measurement, x, on each of n, say, specimens, that on the ith specimen being x_i, for each i from 1 to n, and using the symbol $\Sigma_i x_i$ to represent sum of x_i, over all values of i, we have

Mean $=$ average values $= \Sigma_i x_i / n = \bar{x}$, say

Variance $= \Sigma_i (x_i - \bar{x})^2 / (n-1) = s^2$, say, where standard deviation $= 2$.

The mean and variance are also called the first and second k statistic, k_1 and k_2, respectively.

Third k statistic, $k_3 = n\, \Sigma_i\, (x_i - \bar{x})^3 / \{(n-1)\,(n-2)\}$,

Fourth k statistic,

$k_4 = n\{(n+1)\Sigma_i\, (x_i - \bar{x})^4 - 3\,(n-1)\,(\Sigma_i (x_i - \bar{x})^2)^2 / n\} /$
$\{(n-1)\,(n-2)\,(n-3)\}$.

The measures of skewness and kurtosis are standardised forms of k_3 and k_4, being respectively $g_1 = k_3/s^3$ and $g_2 = k_4/s^4$.

The k statistics estimate corresponding distribution parameters which are called cumulants, and the standardised forms, g_1 and g_2, estimate quantities which, for a normal distribution, are both zero.

One way in which sets of observations are often tested to see whether or not they follow a normal distribution, is by testing whether or not g_1 and g_2 are significantly different from zero. This means that we examine whether or not the deviations of g_1 and g_2 from zero are too large to attribute to random fluctuation, with an underlying normal distribution.

We actually test g_1 using the normal disribution with zero mean and variance

$s^1_2 = 6n(n-1)/\{(n-2)(n+1)(n+3)\}$, and g_2 using the normal distribution with zero mean and variance $s^1_2 = 24n(n-1)^2/\{(n-3)(n-2)(n+3)(n+5)\}$. The method of test is described by Fisher (1954) (see also Shappiro, Wilk and Chen 1968) and Biometrika Tables).

In table 1 we give the mean, x, the variance, s^2, the standard deviation, s, the skewness measure, g_1, and the kurtosis measure, g_2, for each of the five measurements on the snails, and each of the three measurements on the mussels. These quantities are given for the full samples of fifty snails and 100 mussels, also for the incomplete samples obtained by omitting four snails and one mussel, where the measurements were thought to be a little "freakish"—see later in this appendix. None of the omissions changed the results of the significance tests on g_1 and g_2 as indicated by the asterisks appearing in these values, except that in one case the level of significance is changed, as may be seen in table 1. Significant values of g_1 and g_2 are indicated by *,**, and ***, respectively for 5, 1and 0·1 per cent levels, unstarred values being not significant at even the 5 per cent level.

TABLE 1

Descriptive statistics of the distribution of measurements on snails and mussels

(a) Snails (*Pila wernei*)

MEASUREMENT (millimetres)		MEAN	VARIANCE	STAN. DEVN.	SKEWNESS	KURTOSIS	99·8% LIMITS
		$\bar{x}$	s^2	s	g_1	g_2	
1. Length	(50)	63·8	49·3	7·0	−0·052	−0·076	40·6, 87·0
	(46)	63·1	42·6	6·5	−0·311	−0·360	
2. Greatest width	(50)	58·0	42·9	6·6	0·023	−0·127	36·4, 79·6
	(46)	57·5	39·4	6·3	−0·159	−0·429	
3. Aperture length	(50)	51·4	34·9	5·9	0·233	0·514	31·9, 70·9
	(46)	50·5	25·4	5·0	−0·326	−0·426	
4. Aperture width	(50)	28·8	10·0	3·2	−0·244	−0·383	18·4, 39·2
	(46)	28·6	10·2	3·2	−0·123	−0·407	
5. No. of whorls	(50)	4·8	0·122	0·35	−1·488***	0·777	
	(46)	4·8	0·116	0·34	−1·509***	0·929	

Distribution of number of whorls

Number of whorls:	4	4½	5
Estimated probability	0·12	0·16	0·72

(b) Mussels (*Aspatharia complanata*)

MEASUREMENT (millimetres)		$\bar{x}$	s^2	s	g_1	g_2	99% limits and Pearson type
1. Length	(100)	59·3	23·7	4·9	−0·633*	0·350	44·2, 68·4
	(99)	59·4	23·8	4·9	−0·657*	0·390	(Type I)
2. Height	(100)	30·6	9·73	3·1	−0·727**	1·349**	20·2, 37·2
	(99)	30·7	9·15	3·0	−0·687*	1·494**	(Type IV)
3. Width	(100)	18·5	4·52	2·1	−0·503*	0·159	12·2, 22·8
	(99)	18·5	4·56	2·1	−0·515*	0·150	(Type I)

A g value is significant if the probability of observing a value at least that large would be less than the significance level if the data were normal, so this small probability provides evidence against the assumption of normality.

Table 1 also shows 99·8 per cent limits, that is, for each type of measurement of the snails, values between which nearly the whole population of measurements lie. For the distribution of the number of whorls, the simple proportion provides the best estimate of the probability of each number.

Each of the first four measurements on snails is seen to conform with the normal distribution whereas the distributions of the three measurements on mussels are all too negatively skew to conform very well with the normal, also the heights have too high a positive kurtosis. 99·8 per cent limits are not available for these distributions. Using $\beta_1 = g_1^2$, $\beta_2 = g_2 + 3$, and p.210 of Biometrika tables the appropriate type of distribution from the Pearson system of distributions was determined for each of these three measurements, and is stated in Table 1. The same tables were used to estimate the 99·0 per cent limits for these. The shapes of Types I and IV distributions are illustrated by figs. 2 and 3, respectively.

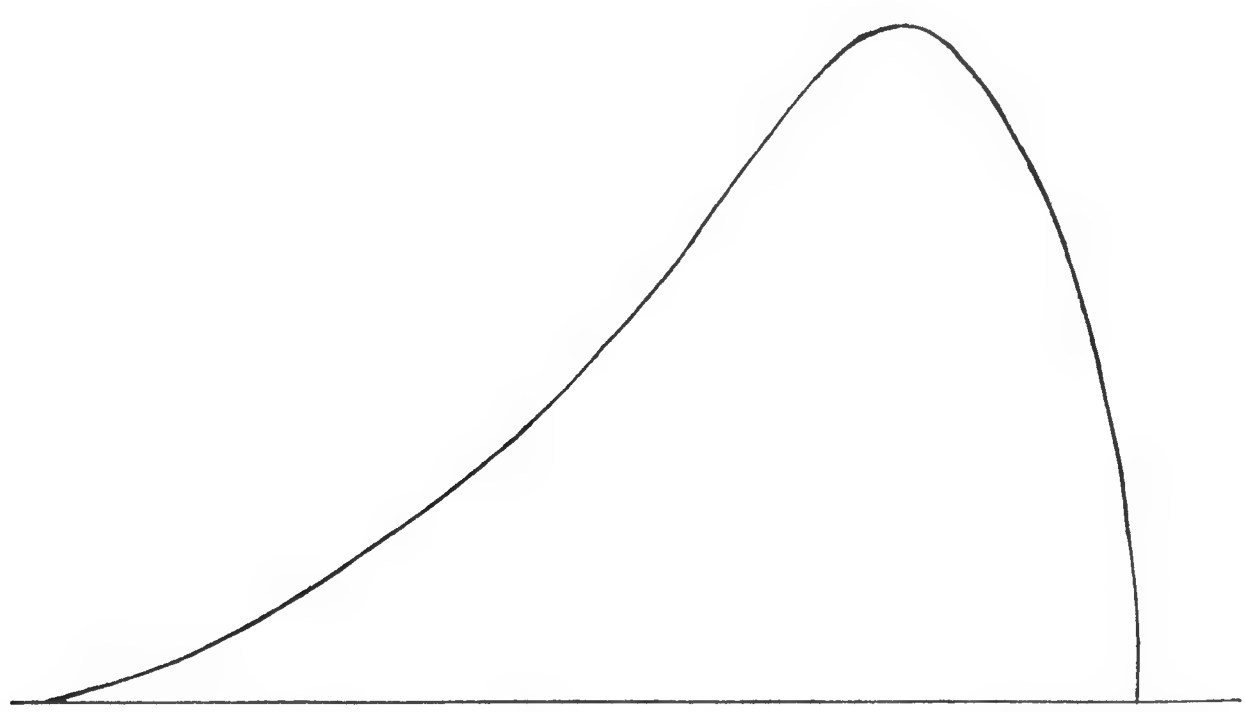

Fig. 2. The Pearson Type 1 distribution.

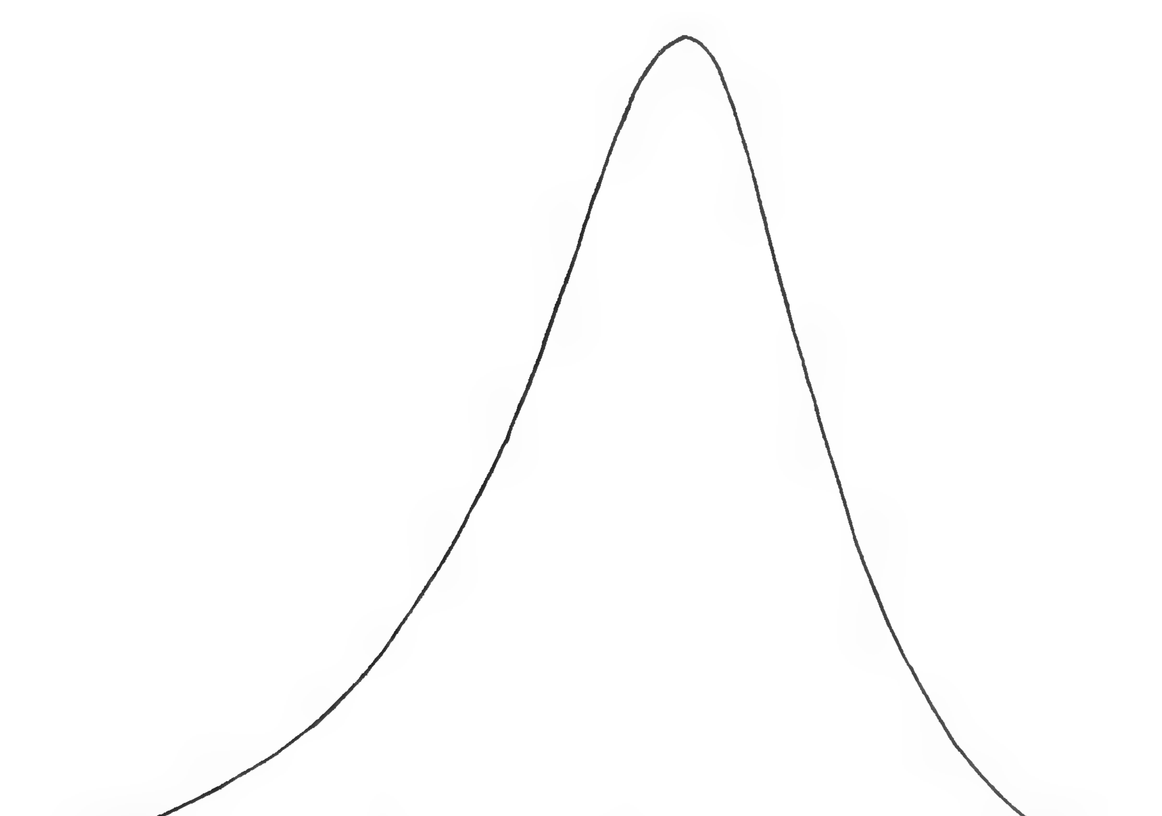

Fig. 3. The Pearson Type 4 distribution.

The significant negative skewness of all measurements in *A. complanata* reveals a paucity of lower values (i.e. small shells). Although not satisfactorily explained, the absence of young individuals in freshwater mussel populations is common. Similarly the highly significant negative skewness for the number of whorls in *P. wernei* indicates the absence of shells with low whorl counts. Since gastropod shells grow on a logarithmic spiral pattern, only very small shells give low whorl counts. Indeed most snails hatch from the egg with a shell of about $1\frac{1}{2}$ whorls. The negative skew results simply from the fact that the sample did not include any very young shells (the smallest shell has length $>$ 45 mm.). The positive kurtosis in the height of *A. complanata* implies a prolonged period of growth during which height remained constant or increased more slowly than length and width.

Correlations between the measurements

These are illustrated pictorially by the scatter diagrams, figs. 4 to 12. Those involving the whorls in combination with each of other measurements on snails were omitted, as they showed no significant relationship of any kind. There was a tendency for four whorls to correspond to the lowest mean value of each of the other measurements, but this tendency was not statistically significant. The figures display the following features:

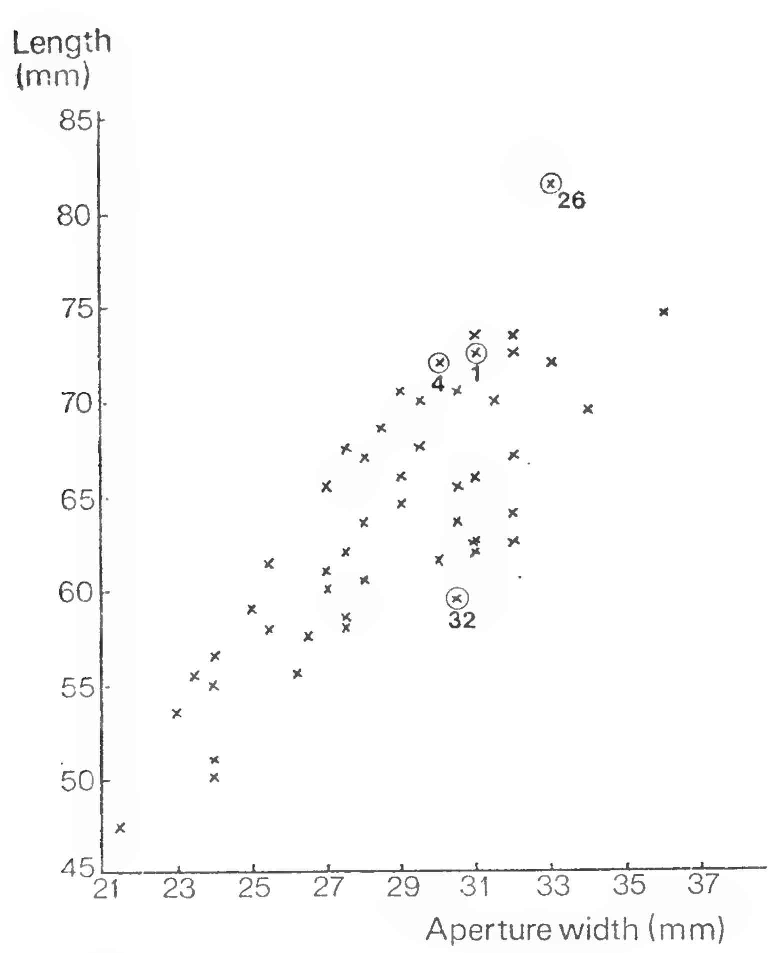

Fig. 4. Scatter diagram – snail measurements.

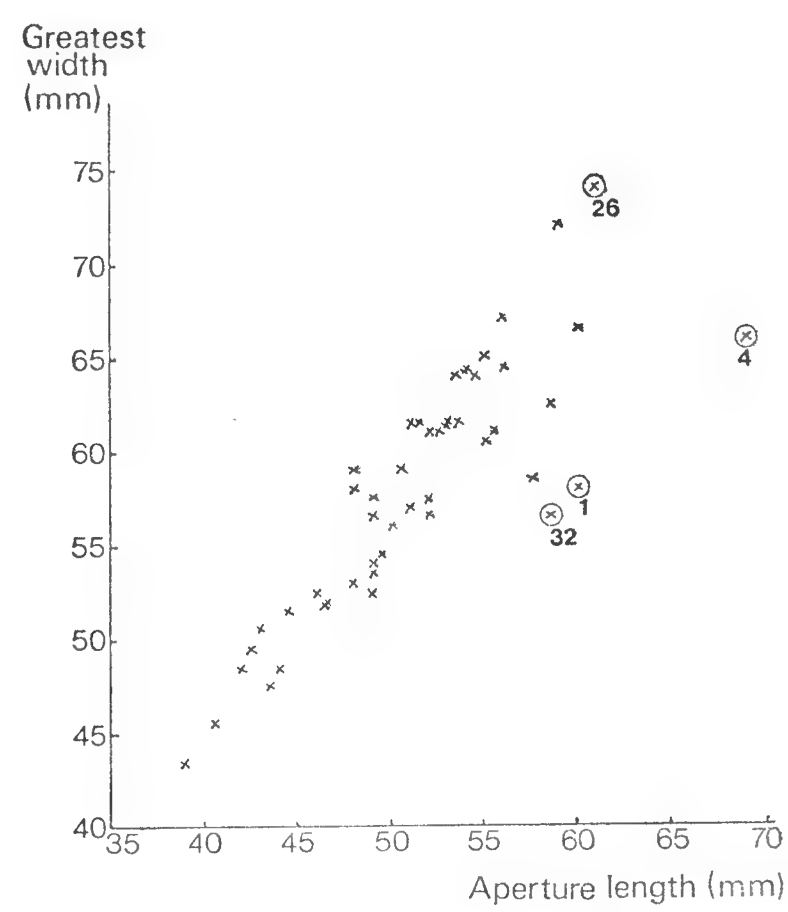

Fig. 5. Scatter diagram – snail measurements.

(a) a marked positive correlation between the first four measurements on snails, also between the three measurements on mussels. This is to be expected, and is confirmed by the corresponding correlation coefficients in Table 2.

(b) four of the specimens of snail and one specimen of mussel appear to give outliers. The corresponding points in the diagrams are ringed and the specimen

numbers are indicated. Concerning the freak snails, specimens 1, 4 and 32 seem to have abnormally large aperture lengths, relatively to their greatest widths, to its aperture width in the case of specimen 4, and to their lengths in the case of specimens 4 and 32; also specimen 26 has an abnormally large length, though this is not unduly inconsistent with its other dimensions.

Specimen 18 of the mussels has an abnormally small height compared to either its length or its width (which are consistent with each other).

These outlier measurements may be due to mutations, or be simply exceptional cases.

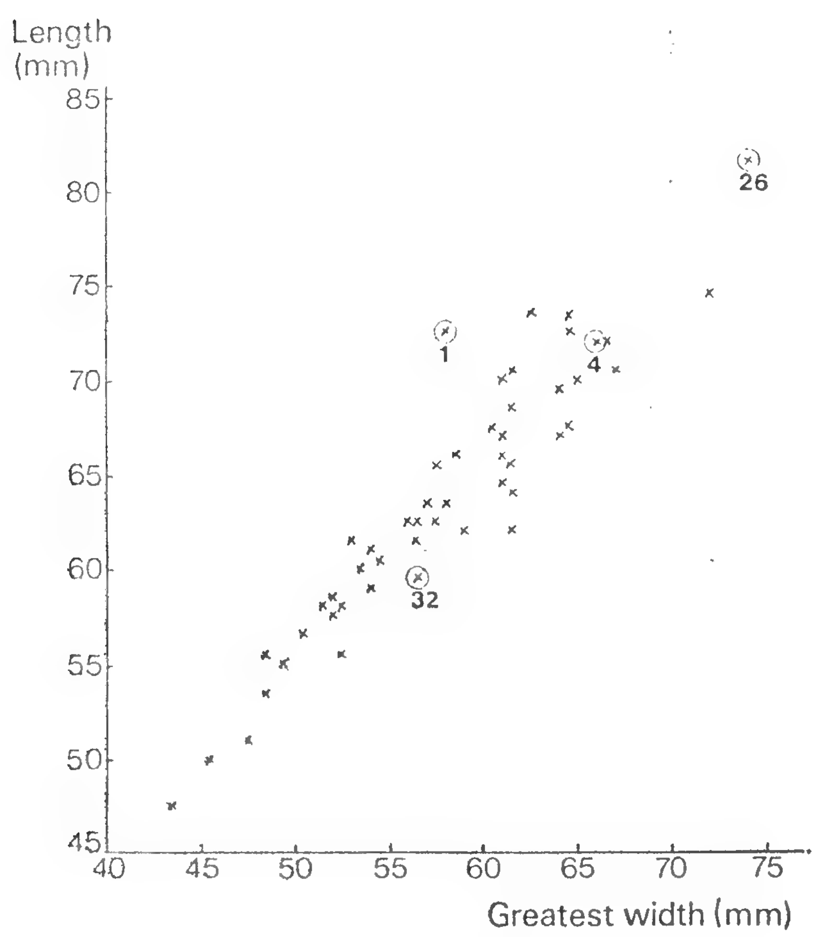

Fig. 6. Scatter diagram – snail measurements.

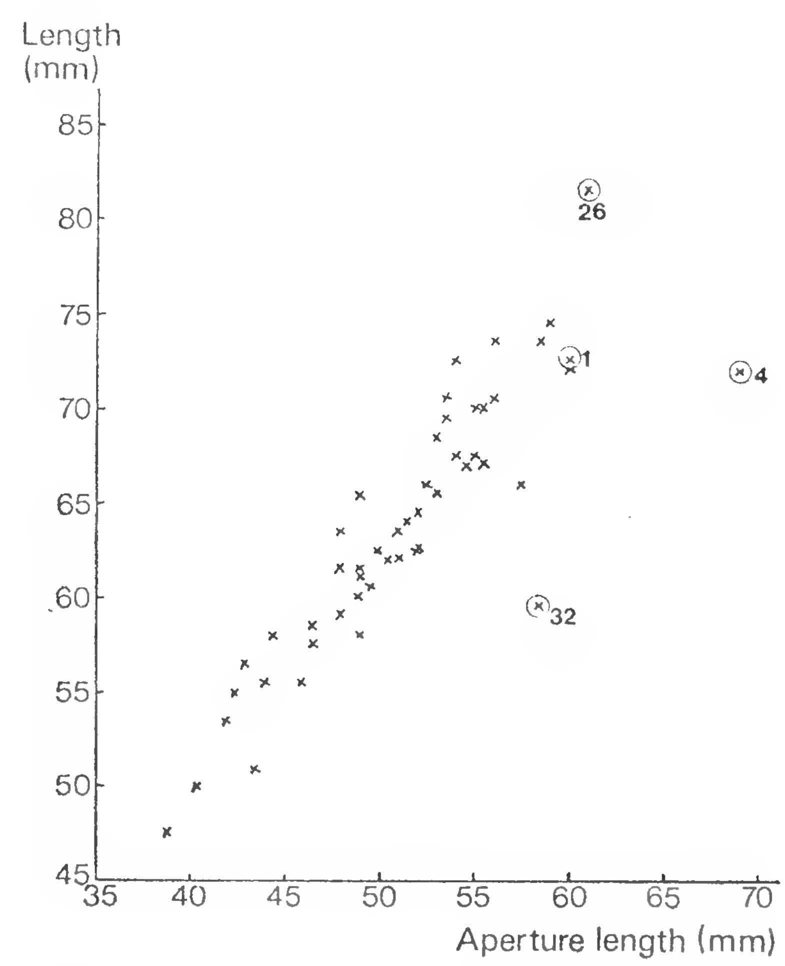

Fig. 7. Scatter diagram – snail measurements.

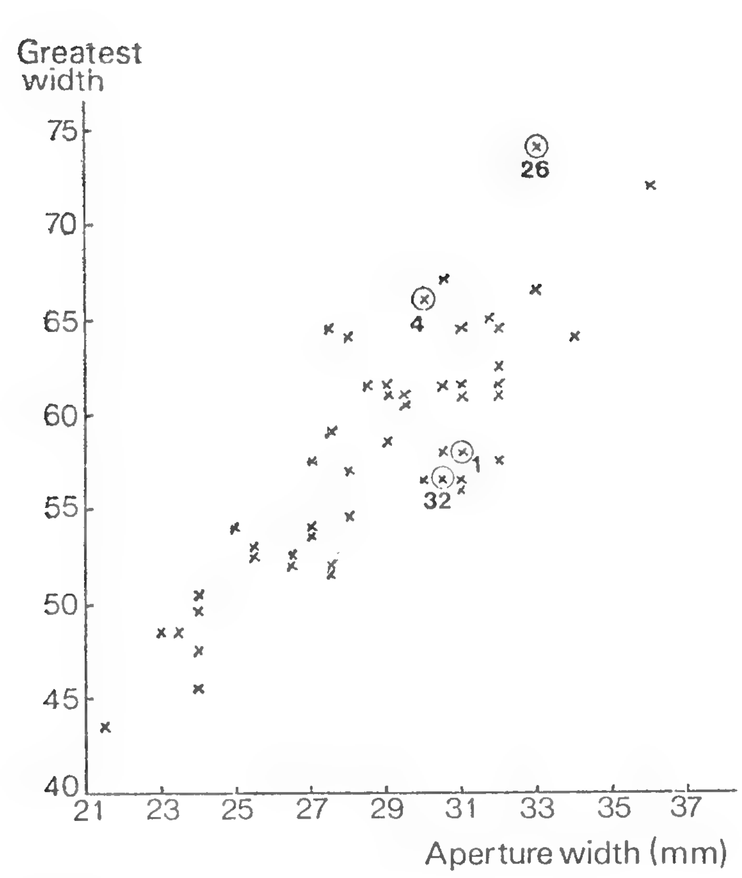

Fig. 8. Scatter diagram – snail measurements.

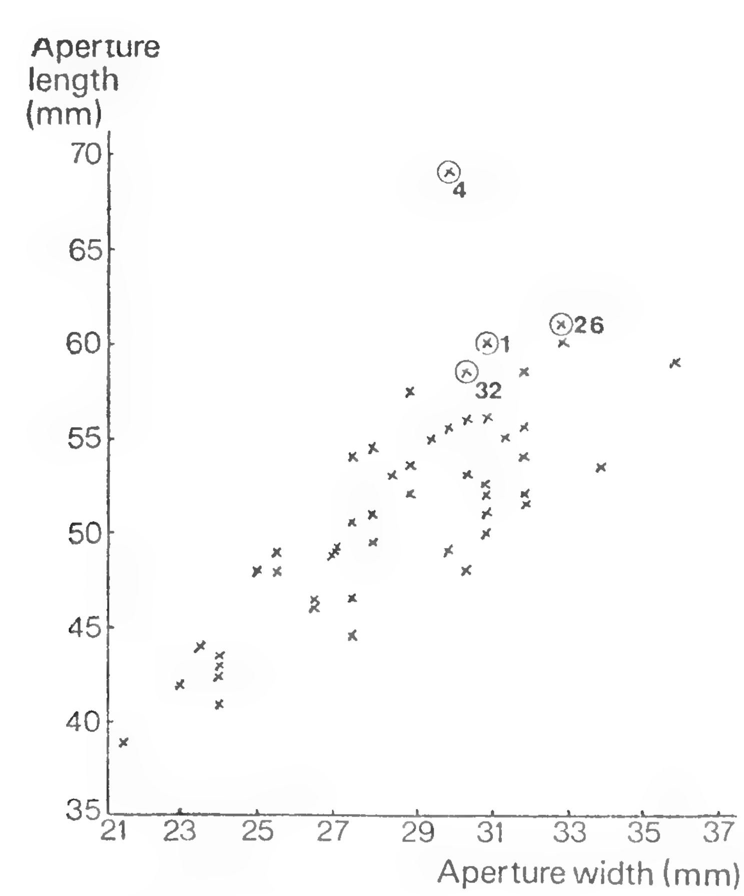

Fig. 9. Scatter diagram – snail measurements.

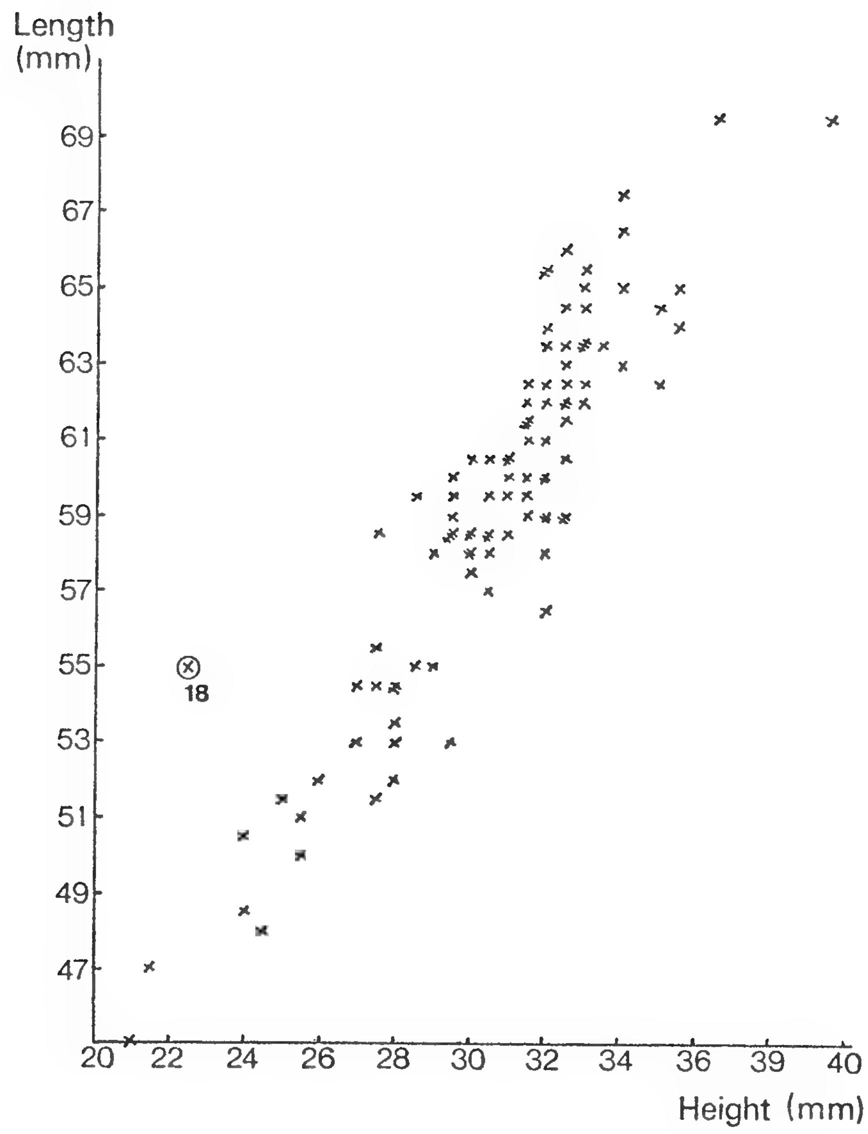

Fig. 10. Scatter diagram – mussel measurements.

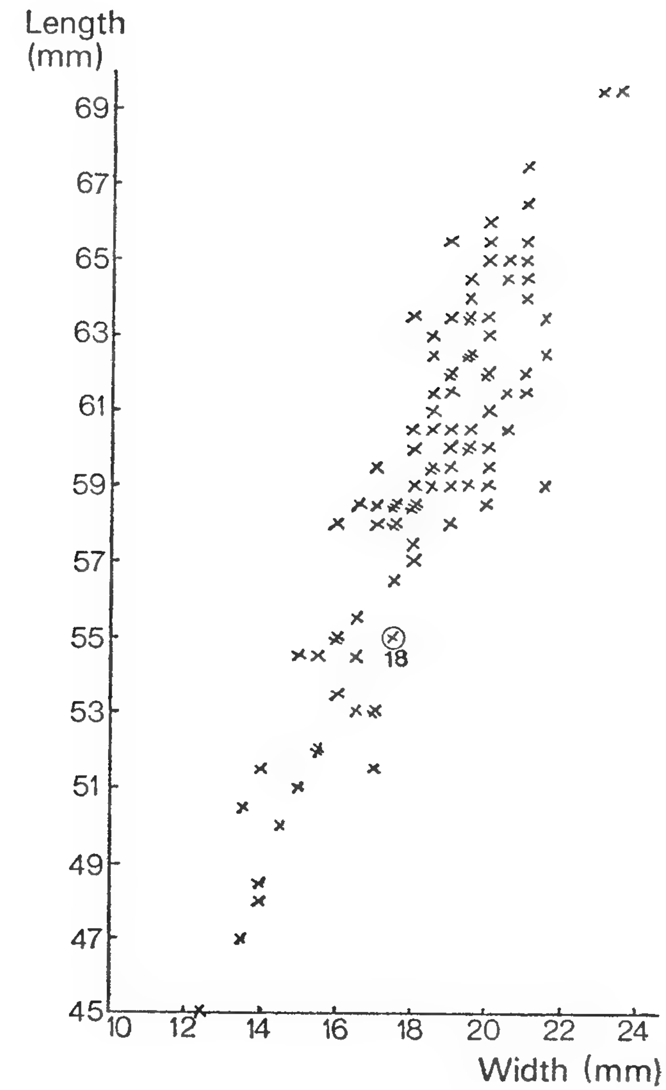

Fig. 11. Scatter diagram – mussel measurements.

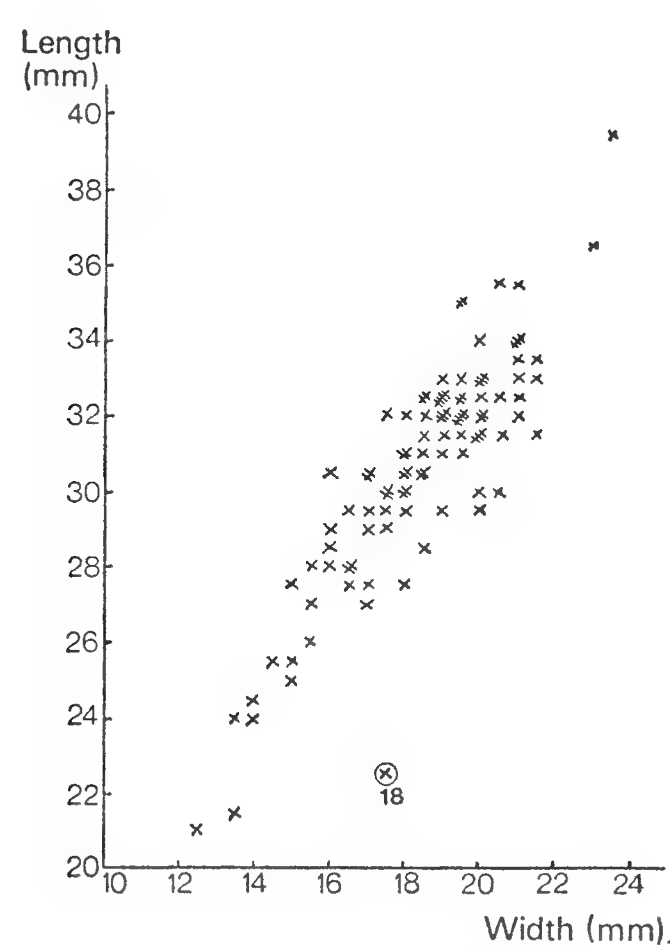

Figure 12. Scatter diagram – mussel measurements.

Table 2 shows the correlation coefficients between the various measurements on snails and between those on mussels. As in Table 1, significance values are shown by asterisks, one, two, three asterisks representing significant at the 5, 1, 0·1 per cent levels, respectively.

For convenience the different measurements are numbered as shown in Table 1,

and r_{ij} represents the correlation coefficient between the ith and jth variables, for example the suffices 12 for snails refer to length and greatest width. The correlation coefficient between a set of pairs of values x_i, y_i ($i = 1, 2, \ldots n$) is given by

$$r = \frac{\Sigma(x_i - \bar{x})\ (y_i - y)}{\{\Sigma(x_i - \bar{x})^2.\ \Sigma(y_i - \bar{y})^2\}^{\frac{1}{2}}}$$

TABLE 2

Correlation coefficients between measurements on snails, and between those on mussels

	SNAILS		MUSSELS	
Sample size:	50	46	100	99
r_{12}	·9398***	−·9482***	·9081***	·9203***
r_{13}	·8773***	·9416***	·8935***	·8940***
r_{14}	·8111***	·8283***		
r_{15}	−·0424	−·0232		
r_{23}	·8558***	·9264***	·8718***	·8921***
r_{24}	·8434***	·8600***		
r_{25}	−·0992	−·1615		
r_{34}	·7733***	·8331***		
r_{35}	−·0153	−·0174		
r_{49}	−·2611	−·2803		

All these correlations are very highly significant (that is, at the 0·1 per cent level) except for those involving measurement 5, the number of whorls, all of which are non-significant, but r_{45}, the correlation coefficients between the aperture width and the number of whorls (which are negative) are nearly significant at the 10 per cent level (two-sided test), the values which would be *just* significant being −0·278 and −0·298 respectively—though the 10 per cent level is a rather weaker significance level than is usually used.

A strong positive correlation, like those obtained between the first four measurements of snails, and those between the measurements for mussels, is an indication that the two variables involved are approximately linearly related, large values of one being associated with large values of the other, and small values of each also going together.

In molluscan terms the shells of both *P. wernei* and *A. complanata* do not change shape significantly during growth through the size range of the samples. The poor correlation between whorl count and all other measures in *P. wernei* results from the logarithmic pattern of growth of gastropod shells. The addition of one whorl to the shell produces a disproportionately large increase in all linear measurements. This low correlation is not due to the erosion of the spire in *P. wernei* which merely involves loss of the periostracum followed by slight pitting of the shell.

We notice that in every case the significant correlations have been increased by the removal of the freakish specimens.

The statistical methods used here are described in a great many introductory statistical books, of which we only mention a few here, namely Loveday, Vols. 1 and 2 (1961), Chatfield (1970), Mulholland and Jones (1968), Moore (1958).

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. Conch. 28: 95–101 (1973)

A LIST OF CAITHNESS LAND AND FRESHWATER MOLLUSCA

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52 Heathfield Road, Thurso, Caithness, Scotland

(*Read before the Society, 17 March 1973*)

This is intended as a simple record of the land and freshwater molluscs living at the present time in Caithness.

All species listed have been verified from living or fresh material seen by the experts in various fields, and all records have been entered by Dr. M. P. Kerney in the Conchological Society's 10 km. mapping scheme.

Caithness encloses twenty-five 10 km. squares within its boundaries, so each species listed have been given a 10 km. square frequency number, e.g. *Valvata piscinalis* Muller (7), means that *V. piscinalis* occurs in seven of the twenty-five 10 km. squares. Each of these squares has been surveyed within the period December 1969 to July 1972. Rare species have been given a 1 km. national grid reference, while notes on habitat have been included for most species.

LIST OF SPECIES

Valvata piscinalis (Müller) (7). Common in many Caithness lochs, such as Loch Calder, Loch Watten, Loch Rangag, Loch Scarmclette and St. John's Loch. The last-mentioned holds a depauperate form while Scarmclette yields superb specimens.

Potamopyrgus jenkinsi (Smith) (14). Very common throughout freshwater habitats. Thurso and Wick Rivers are in the throes of a massive invasion.

Carychium minimum Müller (5). Quite common in damp marshy areas, as by the Thurso and Dunbeath rivers.

C. tridentatum (Risso) (6). Quite common; lives in rather drier areas than *C. minimum* s.s.

Lymnaea truncatula (Müller) (11). Very common, mainly in the grass and marshy areas. Dr. Kerney says of specimens from Quoynee (ND208582) that these are some of the largest he has ever seen.

L. palustris (Müller) (3). Known from two areas only, Loch Scarmclette (ND183598) and the marl lochs of Achscrabster (ND070645). This is an old record from Coghill Loch, Scrabster (C. Oldham, 1932).

L. peregra (Müller) (19). Very common throughout Caithness, and as usual varies much in size and shape. Specimens from St. John's Loch (west end) resemble *L. auricularia* while those in the Loch of Watten resemble *L. peregra* var. *burnetti* (see Ellis, 1969, pl. 3, fig. 10).

Aplexa hypnorum (L.) (1). Only found below the "Iron Brig", Wick River (ND345518) on the stems of the common reed (*Phragmites communis*). This is one of the few authenticated finds of the species in Scotland.

Planorbis leucostoma Millet (6). Very common on flooded ground and should be looked for during the winter months. By the Wick river massive populations can be found in winter, while during the summer months it can only be found with great difficulty.

P. laevis Alder (4). Quite common in Caithness lochs and old quarries, e.g. Loch Calder, Loch Scarmclette, Castletown Quarries. Very fine specimens at Castletown Quarries south.

P. crista (L.) (3). Common in quarry pools. If one leaves an empty polythene bag (preferably one that has held fertiliser) floating in a quarry pool then within a few days many specimens can be taken from the underside of the bag.

P. contortus (L.) (8). Common in the rivers and lochs (6), Wick River and Thurso River. Specimens are always noticeably smaller than their English counterparts.

Ancylus fluviatilis Müller (17). Common throughout and can be taken in nearly every river and stream. Very large specimens in a small burn at Thurso riverside.

Succinea pfeifferi Rossmässler (12). Common in typical habitats. Specimens up to 17 mm. high at Garth, near Castletown (all det. Dr. Lloyd-Evans).

Cochlicopa lubrica (Müller) (15). Common in coastal areas, e.g. Lybster, Wick, Halkirk, Dunbeath and Thurso. Small forms taken at Reay (Sandside) and Oldhall (Watten) are probably this species but Dr. Kerney cannot say with certainty.

C. lubricella (Siemaschko) (4). Quite common but not so widespread as *C. lubrica*. Localities as *C. lubrica*.

Columella edentula (Drap.) (1). Only authenticated so far from marshy ground by Thurso riverside (ND113675) (verified by Dr. C. R. C. Paul).

C. aspera Waldén (4). Very common in the old slate and flag quarries which lie mainly in the northern half of the county, e.g. Castletown, Achscrabster, Weydale and Janetstown quarries (verified by Dr. C. R. C. Paul).

Vertigo substriata (Jeffreys) (1). Very rare. Only at Dunbeath water (ND145305) under a hazel tree on a mossy stone (verified Dr. Kerney).

V. pygmaea (Drap.) (4). Common in Caithness. Localities as *Columella aspera* (q.v). Found almost invariably with that species.

Pupilla muscorum (L.) (2). Rare. Freswick (ND376675) and Sandside (ND968657). In both localities under stones on short maritime turf in very dry situations.

Lauria cylindracea (da Costa) (15). Very common in all coastal and inland, inhabited localities.

L. anglica (Wood) (3). (1) Lybster (ND231346). (2) Thurso riverside (ND113675) and (3) Dunbeath Water (ND146305). Will probably be found more frequently if specifically looked for in suitable habitats.

Acanthinula aculeata (Müller) (1). Very rare. Found only in one locality, the strath at Latheronwheel under beech trees (ND187326). There is an old record for Dunbeath water, made by W. Baillie in the 1880's.

A. lamellata (Jeffreys) (1). Rare, only in two localities, Dunbeath Water (ND145305) and Latheronwheel Strath (ND186329). Both finds were made under beech trees on leaf litter. The Latheronwheel site is quite heavily populated, over fifty specimens being encountered in about thirty minutes using a naturalist's sieve (see Carr 1972 for details of sieve).

Vallonia excentrica Sterki (3). Common where found, although only known from two localities, the S.E. end of Dunnet Bay (ND202682) and Sandside (NC968657). Habitat, stones on very short maritime turf, in dry situations.

Clausilia bidentata (Ström) (10). Common throughout coastal and inland areas where suitable, e.g. South Head Quarry, Wick; Braal Castle, Halkirk; Scrabster etc.

Balea perversa (L.) (5). Not uncommon, favours old cemeteries, such as St. Mary's Chapel, Forss, and Castletown Cemetery. Found also on beech trees at Dunbeath Water where the specimens have no denticle in the aperture.

Arianta arbustorum (L.) (15). Very common throughout coastal and inland areas. A high-spired form at Sandside, Reay.

Cepaea hortensis (Müller) (14). Very common. Bandless shells at Murkle Bay sandhills, whilst at Achscrabster quarries a very large form can be found.

Helix aspersa Müller (2). Rare; the three known colonies at Scrabster (ND098700), Thurso (ND114680), and Ormlie Hill (ND109678) are probably immigrants introduced with timber imported into Scrabster. The colonies are expanding quite rapidly, probably due to mild winters over the last three–four years.

Hygromia striolata (C. Pfeiffer) (8). Common on rubbish tips, e.g. Thurso Castle, Braal Castle, Castletown quarries; can also be found on railway embankments along the county's one railway track.

H. hispida (L.) (2). Not uncommon in its two known localities. These are (1) Stempster House raspberry plantations (ND183609). (2) Dump at Janetstown Quarries (ND095663).

Helicella caperata (Montagu) (3). A large colony at Dunnet sandhills covering three 10 km. squares, probably introduced as it has not been found elsewhere in the county.

H. itala (L.) (3). Common in the same area as *H. caperata* but extends from Dunnet sandhills right round to Thurso Castle. Specimens collected by the naturalist Robert Dick in the 1880's can be seen on display in the Thurso Museum.

Cochlicella acuta (Müller). Has not been found in Caithness since 1904. All four original localities have been searched but only one old shell has been found and the species is probably now extinct in this area.

Punctum pygmaeum (Drap.) (4). Not common, found in four localities. These are Dunbeath Water (ND39/13), Achscrabster (ND39/06), Langwell Forest (ND39/02) and Ben Aliskey (ND39/03).

Discus rotundatus (Müller) (14). Common in most 10 km. squares, hard to find in others and missing from quite a few bleak inland squares.

Arion intermedius Normand (22). Very common throughout, in several varieties.

A. circumscriptus Johnston s.s. (22). Very common in most areas, even in the remotest of peat bogs.

A. silvaticus Lohmander (6). Common in coastal localities, does not have so wide a distribution as *A. fasciatus.*

A. fasciatus (Nilsson) (11). Very common in and around wooded and inhabited areas.

A. hortensis Férussac (17). Common in agricultural areas; it is the commonest *Arion* present in arable fields.

A. subfuscus (Draparnaud) (17). Not uncommon though generally the least common of the *Arion* spp. found during a typical slughunt.

A. ater (L.) s.l. (22). Very common throughout and occurs in several forms. The true *ater* occurs in the remotest of peat bog areas, and appears to be truly native.

Euconulus fulvus (Müller) (13). Common in wooded and sandy localities.

Vitrea crystallina (Müller) (4). Not common, has only been found in the following localities: Thurso riverside (ND39/06), Wick (ND39/35), Camster (ND39/29), and Dunbeath Water (ND39/13).

V. contracta (Westerlund) (9). Common in wooded, sandy and marshy localities, e.g. Thurso riverside, Dunbeath Water and Wick riverside.

Oxychilus draparnaldi (Beck) (5). Common only in rubbish tips, verified by Dr. Kerney.

O. cellarius (Müller) (11). Common throughout in most inland and coastal agricultural areas.

O. alliarius (Miller) (22). Very common throughout, and in general much larger than their English counterparts, sometimes even attaining the dimensions normally met with in *O. cellarius*.

Retinella radiatula (Alder) (4). Not uncommon in the localities where it occurs, e.g. Janetstown quarries, Castletown Olrig etc.

R. pura (Alder) (3). Common in localities where found, similar distribution to *R. radiatula*.

R. nitidula (Drap.) (12). Commonest zonitid found in all coastal and wooded inland localities.

Vitrina pellucida (Müller) (18). Very common in all localities, living specimens are plentiful in December and January.

Milax sowerbyi (Férussac) (2). Very uncommon, four finds only. Scrabster House (ND099698), Janetstown Quarries (ND095663), Forss roadbridge (ND038687), and Wick riverside (ND361509). Probably introduced in the late 1950's, either through Scrabster port or with plants or agricultural imports from the south.

M. gagates (Drap). (2). This species occurs in two areas only, but there it is plentiful. Scrabster House (ND099698) and general in Thurso gardens in the southern half of the town.

M. budapestensis (Hazay) (6). Commonest of the *Milax* spp. in Caithness. Gardens and rubbish tips are typical habitats (Wick, Thurso, Castletown, etc.).

Limax maximus (L.) (9). Common in woods and rubbish dumps. The typical variety found is *vinosa* Baudon.

L. flavus L. The only record of this species in Caithness was made in 1917, by Miss Chatty Mowat in a Wick garden. I have tried to find this species but have not succeeded as yet. It will probably turn up in the near future.

L. marginatus Müller (17). Common in most localities and several varieties are present.

Agriolimax reticulatus (Müller) (25). Common in all 10 km. squares and varies a great deal in colour and size.

A. caruanae Pollonera (8). Very common in populated areas, and it is a serious pest in Thurso gardens, where it replaces *A. reticulatus* as the common garden slug. The characteristic head to tail mating is common in April, May and June.

A. laevis (Müller) (20). Common throughout, but is never so abundant as *A. caruanae*.

Anodonta anatina (L) (3). Common in the following lochs and rivers: Wester loch, Scarmclette loch, Watten loch, Wick river and the Burn of Acharole. Caithness is the only Scottish county north of Perthshire from which this species has been authenticated.

Sphaerium corneum (L.) (8). Common in many lochs and rivers, e.g. Wick river, Forss river, Loch Calder, Loch Watten and Scarmclette loch.

Pisidium casertanum (Poli) (11). Very common, can be found in most lochs, rivers and quarry pools.

P. personatum Malm (5). Common on dried-up ground during the summer found in ditches and wet places generally during the winter.

P. milium Held (6). Common on loch edges during winter flooding (e.g. Lochan Buidhe, Forss river, Loch Scarmclette), also found on vegetation in these lochs well away from the bottom.

P. subtruncatum Malm (9). Common in Loch Heilan, St. John's Loch, Loch Calder and Loch Shurrery.

P. obtusale (Lamarck) (1). I have only found this species in a burn near Killimster Loch (ND313560) and it appears to be scarce in Caithness.

P. lilljeborgii Clessin (4). Common on sandy-bottomed lochs such as Loch of Mey, St. John's Loch, Watten Loch, Sarclet Loch and the Banniskirk Lochan. The rare variety *cristata* Sterki occurs in the Loch of Mey.

P. nitidum Jenyns (9). Common in most lochs, rivers and quarry pools, e.g. Watten Loch, Loch Calder, Loch of Mey etc.

P. hibernicum Westerlund (6). Common in lochs, such as Calder, Shurrery, and Scarmclette.

P. pulchellum (Jenyns) (4). Common in Loch Scarmclette, Forss river, Loch Winless and Loch Heilen. Specimens from Loch Heilen are very fine.

The only previous list of Caithness non-marine Mollusca appears to be that of C. W. Peach, first read before the Royal Physical Society of Edinburgh on March 26th, 1864, and later published in the *J. Conch.* (1884).

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J. Conch. 28: 102 (1973)

REVIEW

Identification of the British Mollusca. G. E. Beedham, 1972. Paperback, pp. 1–239, numerous illustrations. Hulton Educational Publications. Price £1·20.

It is usually easy to criticise a beginner's book on the Mollusca particularly concerning the species included in the descriptive section. With the exception of my disappointment at not finding any coloured photographs, in spite of the comment to the contrary in the Preface, I have nothing but praise for Beedham's book.

Some 215 species are briefly described by means of their diagnostic characteristics and far more than this are illustrated by extremely clear and simple drawings. The inclusion of brief comments and even illustrations of species not fully described in the main text, along with the excellent bibliography, should guide the beginner to the point where he has enough knowledge and experience to be able to identify, from the definitive works, most of the shells he finds.

The book includes the usual chapters on molluscan anatomy, shell morphology and the collection and preservation of molluscs and their shells. More useful sections include a Glossary of Technical Terms and—a must for the beginner—"Notes on the use of a key", and an explanation of the standard binomial system of nomenclature.

It is gratifying to find that the smaller bivalves and a good number of nudibranchs have been included in this text, and apart from the omission of "*Goniodoris nodosa* (Montagu)" from page 68, there is nothing lacking in this book for the enthusiastic beginner.

L. D. Harfield

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SUBFOSSIL AND MODERN LAND-SNAIL FAUNAS FROM ROCK-RUBBLE HABITATS

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INTRODUCTION

In the course of our work on subfossil land-snail faunas from archaeological sites of late Pleistocene and Post-glacial age, we have often been sent, or have collected, material from limestone sites in which rock rubble is abundant. Typical situations are collapsed wall débris, stone cairns, the thermoclastic scree of caves, and rubble horizons in the infilling of ancient ditches.

Initially, shell assemblages from such material were considered to be contemporary with the deposits in which they occurred, and were interpreted along classical lines in terms of the vegetation structure and other environmental parameters obtaining at the time of deposition. However, the evidence from two sites, namely Longhole and Cadbury-Camelot, necessitated a reappraisal of this approach. At Longhole, a limestone cave in the Gower Peninsula, thermoclastic scree, which on the evidence of its lithology, its contained artefacts, and its small mammal fauna was of late Pleistocene age and reflected a cold climate, contained a land-snail fauna which at the earliest was mid-Post-glacial in origin and clearly a reflection of fully temperate conditions. At Cadbury-Camelot, an Iron Age hillfort in Somerset, the fauna from a rock-rubble horizon in the infill of one of the ditches appeared to indicate unequivocably a woodland environment even though the lithological evidence pointed to extreme surface instability during its deposition and an environment in which vegetation of any kind was probably absent.

Furthermore, the faunas from these situations all had certain features in common—an abundance of *Oxychilus, Vitrea* and *Discus*, and a paucity of *Retinella pura*, *R. nitidula* and *Carychium*. Open-country species (*Vallonia*, *Pupilla* and *Helicella*) were generally rare or absent, as was a group of species of somewhat catholic taste—*Punctum pygmaeum*, *Euconulus fulvus*, *Retinella radiatula* and *Vitrina pellucida*. Rupestral species, too were not noticeably abundant.

The abundance of *Oxychilus* and *Vitrea*, both genera which are characteristic of caverns, cellars and underground places generally, suggested that we are dealing with faunas which were actually living within the interstices of the rock-rubble, and this indeed appears to be the case. Unlike chalk, limestone weathers but slowly, and deposits of coarse scree and rubble maintain an open lattice structure almost indefinitely within which many snail species may find favourable conditions for life, even though the general environment be totally open. This is most strongly apparent in Foxhole Slade (see below), a dry valley in Carboniferous Limestone in the Gower Peninsula where areas of grassland and scree exist in close proximity (Plate 1), each supporting a different fauna, the one dominated by *Vallonia excentrica* and species of *Helicella*, the other by *Discus rotundatus* and other "woodland" species in a landscape which in many respects is probably similar to that which obtained during the closing stages of the Last Glaciation.

In this paper, a number of subfossil and modern faunas from rock-rubble situations are described. The modern faunas were investigated in an attempt to find living parallels to the ancient assemblages, an attempt which proved much more difficult than we had anticipated. Nevertheless, with the final discovery of the various faunas in Foxhole Slade, the other faunas investigated could be more sensibly interpreted and are included here as examples of the variation which occurs within rock-rubble habitats. One critical factor is the presence or absence of vegetable mould. Another is the past history of a site, and in particular the degree to which it has been disturbed or otherwise influenced by man.

METHODS

The method used to extract the shells was that described by Evans (1972 : 44). All shells and apices greater than 0·5 mm. were extracted and counted. The weight of the samples, air dried, and excluding stones greater than 1·5 cm. in diameter, is 1·0 kg., unless otherwise stated. The results of analysis have been presented in tabular form as an appendix (Tables 1, 2 and 3), and representative faunas as histograms (Figs. 2 and 3).

In certain instances, large shells, hand-picked during excavation have been included in the tables and/or histograms, in the latter, only where it was considered that they did not unduly bias the composition of the fauna. In each case the exact method of collecting the samples and compiling the histograms and tables has been stated. The criteria for dealing with such shells have been somewhat arbitrary, but in fact, the species in question—mainly *Arianta, Cepaea* and *Helix aspersa*—generally do not comprise an important part of the faunas and are not critical to the discussion.

In the modern samples, only shells of living animals or of those recently dead—as indicated by an intact periostracum—were counted. Subfossil shells, which were in fact few, were discarded.

Apart from the usual difficulties of separating the juveniles and apices of the two species of *Cochlicopa* and those of *Cepaea*, and the virtual impossibility of

identifying the various species of Limacidae, all shells were identified down to the species level.

Five of the sites (one modern and four ancient) have been fully published by other workers, and the species lists from these have not therefore been included in the appendix.

TABLE 1

	Cathole					Long-hole	Whitton				Caer-went
Site / Layer	B	C	D	E	F		13	11	9	8	
Pomatias elegans (Müller)	8	29	255	272	38	82	–	–	–	–	–
Acicula fusca (Montagu)	–	4	9	65	10	42	–	–	–	–	–
Carychium tridentatum (Risso)	–	4	9	88	10	92	15	69	55	30	229
Succinea putris (Linné)	–	–	–	–	–	–	–	1	cf. 2	cf. 10	–
Cochlicopa lubrica (Müller)	–	–	–	3	–	–	4	43	3	9	2
Cochlicopa lubricella (Porro)	–	–	–	–	–	1	–	–	–	–	6
Cochlicopa spp.	1	1	1	8	–	8	–	–	2	–	21
Pyramidula rupestris (Draparnaud)	–	1	2	6	–	125	–	–	–	–	6
Vertigo pygmaea (Draparnaud)	–	–	–	–	–	7	–	1	–	1	–
Pupilla muscorum (Linné)	1	–	–	–	–	4	cf. 1	–	–	–	–
Lauria cylindracea (da Costa)	–	1	5	17	1	63	1	–	–	–	26
Acanthinula aculeata (Müller)	1	–	4	7	–	23	1	–	–	–	25
Vallonia costata (Müller)	–	–	–	–	–	–	8	3	3	6	1
Vallonia excentrica Sterki	2	cf. 1	–	–	–	9	–	–	–	–	–
Ena obscura (Müller)	–	–	–	–	1	4	–	–	–	–	3
Marpessa laminata (Montagu)	–	–	–	1	–	1	–	–	–	–	4
Clausilia bidentata (Ström)	1	2	17	39	9	58	–	–	10	8	28
Balea perversa (Linné)	–	–	–	2	–	–	1	–	–	–	–
Cecilioides acicula (Müller)	1	1	2	29	6	–	–	–	–	–	13
Helicigona lapicida (Linné)	–	–	–	–	–	–	–	–	–	–	+
Arianta arbustorum (Linné)	–	+	1	cf. 1	–	–	1	10	83	14	36
Helix hortensis Müller	–	3	3	4	1	–	1	–	1	2	5
Helix nemoralis Linné	–	1	5	27	2	1	–	–	1	–	4
Arianta, Helix (*Cepaea*) spp.	2	20	43	68	8	72	4	60	128	173	19
Helix aspersa Müller	–	1	6	41	15	3	3	1	–	–	18
Hygromia hispida (Linné)	1	8	18	76	8	34	29	36	34	26	59
Helicella caperata (Montagu)	–	–	–	–	–	10	–	–	–	–	–
Helicella itala (Linné)	–	–	–	–	–	11	–	–	–	–	–
Punctum pygmaeum (Draparnaud)	–	–	–	–	–	–	–	–	–	–	2
Discus rotundatus (Müller)	42	121	72	827	110	707	44	85	27	32	564
Euconulus fulvus (Müller)	–	–	–	1	–	–	–	–	–	–	4
Vitrea crystallina (Müller)	–	1	–	11	cf. 1	–	–	–	–	–	–
Vitrea contracta (Westerlund)	26	23	130	214	19	364	21	cf. 7	cf. 8	cf. 3	272
Oxychilus draparnaldi (Beck)	–	–	?1	–	?1	–	–	–	–	–	–
Oxychilus cellarius (Müller)	33	67	96	168	31	349	6	12	19	12	160
Oxychilus alliarius (Miller)	?6	–	–	–	–	cf. 15	–	–	–	–	–
Oxychilus helveticus (Blum)	–	–	cf. 1	cf. 5	cf. 1	–	cf. 3	cf. 2	–	–	–
Retinella radiatula (Alder)	–	–	–	–	–	1	–	–	–	–	–
Retinella pura (Alder)	–	2	9	46	2	31	–	–	–	3	73
Retinella nitidula (Draparnaud)	–	4	33	70	11	27	–	–	cf. 1	–	42
Zonitoides nitidus (Müller)	–	–	–	–	–	–	2	?1	–	–	–
Vitrina pellucida (Müller)	–	2	1	–	2	6	–	26	10	3	3
Limacidae	9	4	4	20	2	13	15	133	76	23	1

+ = non-apical fragments only

TABLE 2

Site / Layer	Court Hill			Cad-cong	But-combe	Catsgore			Cadbury-Camelot: Ditch 1		Cadbury-Camelot: Ditch 2	
	3	2	1			7	6	4	Primary fill	Shell layer	115–130	90–110
Pomatias elegans (Müller)	74	28	549	2	8	1	3	2	5	–	–	–
Acicula fusca (Montagu)	3	3	4	2	–	–	–	–	–	–	–	–
Carychium tridentatum (Risso)	30	6	4	3	–	11	33	2	10	53	–	45
Lymnaea truncatula (Müller)	–	–	–	–	–	–	–	–	–	–	–	–
Azeca goodalli (Férussac)	–	–	–	–	1	–	–	–	–	–	–	–
Cochlicopa lubrica (Müller)	5	2	7	–	–	–	–	–	1	–	–	–
Cochlicopa lubricella (Porro)	–	–	–	–	–	–	–	–	–	–	–	12
Cochlicopa spp.	–	–	–	+	1	+	12	–	2	7	–	–
Pyramidula rupestris (Draparnaud)	–	–	–	5	–	–	–	–	–	–	–	–
Vertigo pygmaea (Draparnaud)	3	–	–	4	8	5	1	4	7	10	–	7
Pupilla muscorum (Linné)	14	2	1	–	3	1	–	9	19	9	18	4
Lauria cylindracea (da Costa)	23	3	1	–	–	–	–	–	208	2	1	–
Abida secale (Draparnaud)	–	–	–	2	–	–	–	–	–	–	–	–
Acanthinula aculeata (Müller)	–	2	3	–	–	1	4	–	3	19	–	8
Vallonia costata (Müller)	–	–	–	–	–	44	34	27	38	73	41	10
Vallonia excentrica Sterki	56	51	3	4	15	34	37	26	58	108	161	51
Ena obscura (Müller)	–	–	–	1	–	+	1	–	11	17	4	1
Marpessa laminata (Montagu)	–	1	1	–	1	–	–	–	–	2	–	2
Clausilia bidentata (Ström)	3	2	3	31	9	1	9	–	37	65	–	14
Cecilioides acicula (Müller)	8	19	2	154	9	26	34	53	4	142	–	26
Helicigona lapicida (Linné)	+	–	14	6	3	–	–	–	8	15	1	4
Helix hortensis Müller	–	–	–	–	1	–	–	–	–	–	–	–
Helix nemoralis Linné	4	1	328	3	5	–	–	–	13	7	–	3
Helix (*Cepaea*) spp.	–	–	–	17	38	2	4	1	26	22	9	10
Helix aspersa Müller	–	–	–	+	3	3	3	1	+	15	–	6
Hygromia striolata (C. Pfeiffer)	14	61	26	–	14	–	1	–	–	–	–	–
Hygromia hispida (Linné)	–	–	2	18	14	61	63	18	54	107	10	38
Helicella itala (Linné)	18	9	7	–	3	5	1	11	30	90	28	15
Punctum pygmaeum (Draparnaud)	–	–	–	–	–	4	5	2	4	5	2	–
Discus rotundatus (Müller)	282	124	257	79	83	13	59	1	164	740	9	355
Vitrea crystallina (Müller)	–	–	–	–	2	–	–	–	–	–	–	–
Vitrea contracta (Westerlund)	396	60	118	27	–	2	5	–	121	409	3	232
Oxychilus cellarius (Müller)	299	90	179	45	17	4	10	–	114	241	1	160
Oxychilus alliarius (Miller)	–	–	–	–	–	–	–	–	?7	–	–	–
Retinella radiatula (Alder)	–	1	+	–	–	–	–	–	–	–	–	1
Retinella pura (Alder)	6	4	3	–	–	–	–	–	–	6	–	8
Retinella nitidula (Draparnaud)	8	9	17	1	2	11	18	–	7	46	–	32
Vitrina pellucida (Müller)	2	–	1	–	–	–	1	–	1	4	–	2
Limacidae	–	–	–	2	1	21	52	21	13	5	4	6

+ = non-apical fragments only

TABLE 3

Site / Layer	Ascott-u Wychwood Sub-fossil	Ascott-u Wychwood Modern	Seamer Moor	Fox-hole II	Slade I	Dinas Powis II	Dinas Powis I	Min-ster Lovell
Pomatias elegans (Müller)	20	10	–	68	34	3	–	–
Acicula fusca (Montagu)	–	–	–	–	–	15	–	–
Carychium tridentatum (Risso)	86	1	4	32	15	75	11	43
Succinea pfeifferi Rossmässler	–	–	–	–	–	–	–	cf. 1
Cochlicopa lubrica (Müller)	–	5	–	–	–	1	3	–
Cochlicopa lubricella (Porro)	–	1	–	–	–	–	3	–
Cochlicopa spp.	3	7	–	–	–	7	17	–
Pyramidula rupestris (Draparnaud)	–	1	–	37	176	–	1	–
Vertigo pygmaea (Draparnaud)	–	–	1	–	–	–	–	3
Pupilla muscorum (Linné)	–	–	2	–	–	–	–	–
Lauria cylindracea (da Costa)	–	–	–	2	1	–	315	–
Acanthinula aculeata (Müller)	5	–	–	1	–	24	–	5
Vallonia costata (Müller)	1	1	2	–	–	–	49	1
Vallonia excentrica Sterki	2	2	10	–	–	–	–	–
Ena montana (Draparnaud)	3	–	–	–	–	–	–	–
Ena obscura (Müller)	1	6	1	–	–	–	–	–
Marpessa laminata (Montagu)	4	3	–	–	–	–	–	1
Clausilia bidentata (Ström)	7	14	–	172	12	13	7	11
Balea perversa (Linné)	–	–	–	–	–	–	4	–
Cecilioides acicula (Müller)	64	1	8	–	–	–	–	–
Helicigona lapicida (Linné)	1	–	–	–	–	–	–	–
Arianta arbustorum (Linné)	–	–	6	–	–	–	14	–
Helix hortensis Müller	–	–	9	–	–	–	3	+
Helix nemoralis Linné	+	–	1	13	–	–	–	1
Arianta, Helix (*Cepaea*) spp.	3	–	6	43	4	14	–	3
Helix aspersa Müller	–	–	–	3	12	–	10	4
Hygromia striolata (C. Pfeiffer)	12	57	–	–	–	–	5	7
Hygromia hispida (Linné)	14	13	3	–	–	12	22	8
Monacha cantiana (Montagu)	–	+	–	–	–	–	–	–
Helicella virgata (da Costa)	–	cf. 4	–	–	–	–	–	–
Helicella itala (Linné)	3	–	2	–	–	–	–	–
Punctum pygmaeum (Draparnaud)	–	1	–	2	–	–	8	12
Discus rotundatus (Müller)	35	52	9	183	181	93	129	53
Vitrea crystallina (Müller)	2	–	2	–	–	12	–	–
Vitrea contracta (Westerlund)	3	–	11	6	94	82	–	10
Oxychilus cellarius (Müller)	10	5	16	22	31	11	5	28
Oxychilus alliarius (Miller)	–	–	–	–	–	–	54	1
Oxychilus helveticus (Blum)	–	cf. 2	–	–	–	–	–	–
Retinella radiatula (Alder)	–	–	–	–	–	1	–	–
Retinella pura (Alder)	12	1	1	49	–	17	20	23
Retinella nitidula (Draparnaud)	23	9	1	9	–	6	6	13
Vitrina pellucida (Müller)	–	5	1	–	–	14	19	6
Limacidae	–	3	–	–	–	1	–	3

+ = non-apical fragments only

NOTE ON THE SOIL SAMPLES

The soil samples from archaeological sites were generally reddish in colour, particularly those deriving from the Carboniferous Limestone. Those from the younger, Jurassic, limestones had a yellowish/brown tinge. These colours were sometimes masked by humic material, giving the soil a dark-brown or grey colouration—a feature of all the modern samples.

A number of samples which were examined were completely devoid of shells, even though limestone fragments were present. This is in contrast to sites on the Chalk where such an occurrence is extremely rare, and is probably due to the slow rate of weathering of limestone as opposed to that of chalk so that the soil matrix may become decalcified even in juxtaposition to limestone fragments, and the shells in it destroyed.

The age of the subfossil faunas ranges from mid-Post-glacial (*c.* 4000 B.C.) to the medieval period. We have not, however, discussed critically the archaeological horizons and provenances of the faunas for the simple reason that in many of the sites addition of shells to the deposits may have taken place over long periods of time. All that is certain is the earliest possible age of the faunas. But with a few exceptions which are mentioned as they arise—e.g. the often high abundance of *Hygromia striolata* in the modern faunas—we consider the habitat to be of over-riding importance in controlling the composition of the assemblages, not age.

THE SITES

The location of the majority of sites investigated and their position in relationship to the various limestone strata are shown in Fig. 1. They lie between the Gower Peninsula on the South Wales coast in the west and central Oxfordshire in the east, with an extension southwards into Somerset. Of the four sites not shown, two are in north Derbyshire on the Carboniferous Limestone of the Peak District, a third is in the North Riding of Yorkshire on the Corallian, and a fourth is in Co. Clare, Ireland, on Carboniferous Limestone.

Sixteen ancient sites, from which subfossil faunas have been obtained, are described first, followed by six modern sites. The order adopted in each case is a geographical one, commencing with those in South Wales, proceeding to the Mendips/Somerset group, then to Oxfordshire and finally to those peripheral to the main concentration—Derbyshire, Yorkshire and Ireland.

ANCIENT SITES

Cathole, Glamorgan (SS 538900)

The site is a cave in a precipitous outcrop of Carboniferous Limestone at the side of a small dry valley in the Gower Peninsula (Fig. 1). An excavation of the talus slope outside the mouth of the cave revealed a series of Pleistocene and Post-glacial deposits (McBurney, 1959), the upper of which consisted of rock

rubble in a matrix of finer humic material. Six samples, comprising a vertical series through the deposits, together with some shells collected during the excavation (all kindly provided by Dr. J. Campbell) were analysed as follows (details in McBurney, 1959 : Plate XX) :

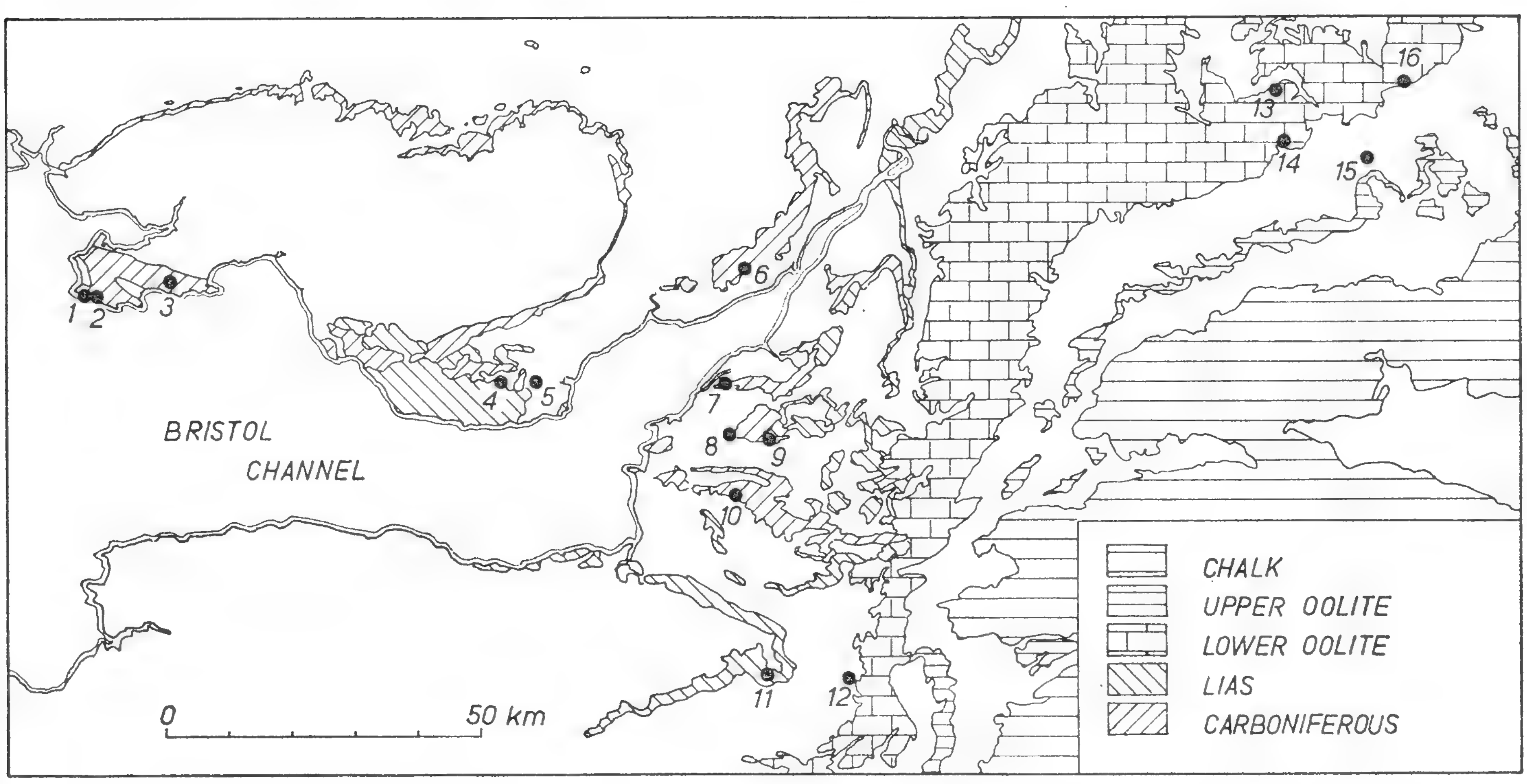

Fig. 1. Location map of sites.

(Based upon the Ordnance Survey Map with the sanction of the Controller of H.M. Stationery Office, Crown copyright reserved.) 1, Foxhole Slade. 2, Longhole. 3, Cathole. 4, Whitton. 5, Dinas Powis. 6, Caerwent. 7, Court Hill Cairn. 8, Cadbury-Congresbury. 9, Butcombe. 10, Sun Hole Cave. 11, Catsgore. 12, Cadbury-Camelot. 13, Ascott-under-Wychwood. 14, Minster Lovell. 15, Wytham Woods. 16, Middleton Stoney. Upper Oolite includes Portland Beds and Corallian; Lower Oolite includes Great and Inferior Oolite.

Layer	*Age*	*Weight* (*kg.*)
F	Modern soil	0·20
E	Medieval to 19th cent.	0·55
D	Bronze Age	0·25
C	Early Post-glacial	0·25
B	Late Pleistocene	1·0
A	Late Pleistocene	1·2

The results of analysis have been presented in histogram form (Fig. 2). Four broad ecological groups may be recognised—troglophile, "woodland", catholic and open-country—and these are discussed in detail in a later section (The faunas).

The assemblages are rich in numbers and species, and are characteristic of rock-rubble habitats, particularly in Layers B and C where the troglophile element predominates. In the upper levels, the "woodland" element becomes important, and this may be seen as a reaction to a greater quantity of leaf litter and other organic material of plant origin in the habitat.

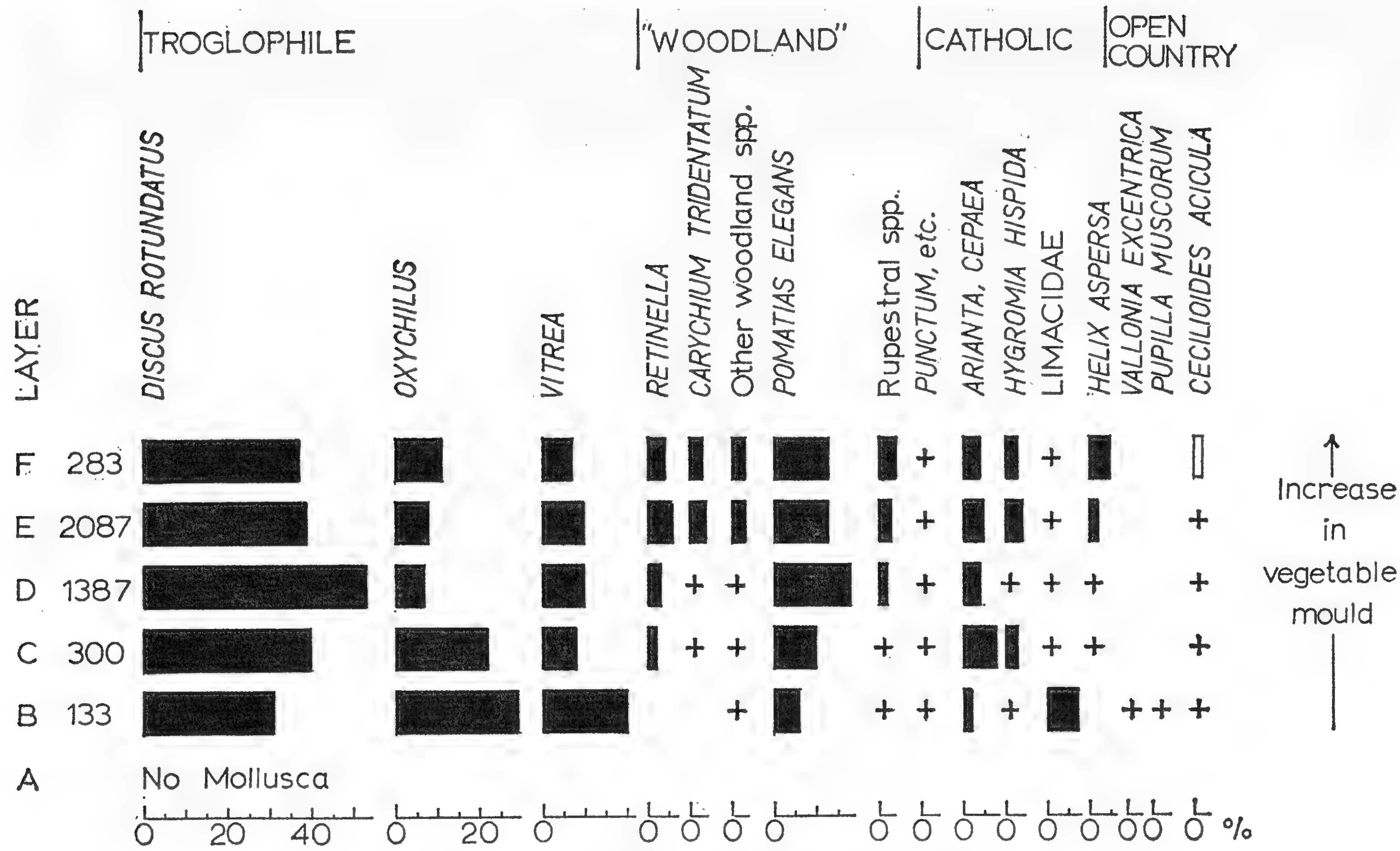

Fig. 2. Cathole. Land-snail histogram.

There is an evident disparity between the age of the deposits as deduced from their lithology, small mammals and archaeological material, and that of the molluscan faunas (Dr. J. Campbell, personal communication). From what is known about the introduction of various species of snail into Britain since the end of the Last Glaciation (Kerney, 1966; Kerney, *et al.*, 1964), the assemblage from Layer B can hardly be earlier than *c.* 6000 B.C., *Pomatias elegans*, in particular, not being present in Britain before that time. In addition, the general composition of the fauna throughout reflects fully temperate climatic conditions, the usual Late-glacial species—*Pupilla*, *Vallonia*, *Helicella and Cochlicopa*—being rare or absent. The shells are thus unlikely to be contemporary with the deposits in which they occur, and it seems probable, therefore, that some have been worked down by earthworm or rodent activity, and that others derive from animals which were once living in the crevices of the rock rubble.

Longhole, Glamorgan (SS 451851)

The site is a cave in Carboniferous Limestone on the south coast of the Gower Peninsula, 1·6 km. south-east of the famous Paviland Cave. A sample (1·0 kg.) from the earthy rock rubble in the upper levels of the talus slope (kindly provided by Dr. J. Campbell) was analysed, and yielded a fauna very similar to those from Cathole (Fig. 3). The only important difference was the scarcity (4%) of *Pomatias elegans* at Longhole, and the greater abundance of rupestrals. Although late Upper Palaeolithic (Cresswellian) artefacts have been obtained from this deposit, the molluscan fauna, as at Cathole, reflects a temperate climate and is almost certainly of later origin.

Whitton, Glamorgan (ST 082714)

The site is a Roman villa situated at about 80 m. O.D. in the rich agricultural land of the Vale of Glamorgan. The geological solid is Lower Liassic Limestone; drift cover is virtually absent. The site was excavated by Dr. M. G. Jarrett for the Department of the Environment between 1966 and 1970.

Four samples (each approx. 2·0 kg.) from a 4th century A.D. well, together with some shells picked out during excavation (mainly *Arianta arbustorum* and *Cepaea* spp.) were analysed by Mr. James Kenworthy as follows:

Layer	
8	Semi-waterlogged clay; stones few
9	Waterlogged organic débris
11, 13	Organic débris with numerous limestone fragments

The deposits most noticeably rich in shells were low down in the well (5·6 to 7·0 m. below the surface) and were associated with a horizon rich in organic remains, largely mosses and wood fragments.

The environment in which the snail faunas were living differed from that of most of the other sites discussed in this paper in two ways. In the first place, it contained less rock rubble, and secondly, it was damper. This is shown by the abundance of *Carychium* (Fig. 3), a species generally rare or absent from true rock-rubble faunas. The high abundance of the catholic group is also foreign to such faunas and here may reflect the generalised nature of the site. Only in the virtual absence of *Retinella* does the fauna resemble those from rock-rubble habitats.

The presence of *Vallonia costata* in a fauna from which other open-country species are absent is, as is discussed below, probably an indication of the rubbish-dump nature of the habitat.

Caerwent, Monmouthshire (ST 468908)

The Roman town of Caerwent is situated on non-calcareous rocks (Keuper Marl) and river gravel, but the town wall, bastions and buildings are made up largely of Liassic Limestone. This has in effect upgraded the lime content of about 40 acres of land, and, as at Middleton Stoney, has made for a richer snail fauna than would otherwise have been the case.

During the 1971 excavations conducted by Mr. John Casey for the Department of the Environment, a sample of rubble and earth, weighing 3·0 kg., was taken from the base of tumbled building débris at the foot of one of the north bastions. The material is probably of late Roman age though the intrusion of shells at a later date cannot be ruled out.

Shells were abundant (Fig. 3). *Discus rotundatus* predominated, with *Oxychilus* and *Vitrea* as important elements. But the abundance of *Retinella* and *Carychium*

was unusually high for rock-rubble faunas, and in this respect the assemblage resembles those from the upper levels at Cathole.

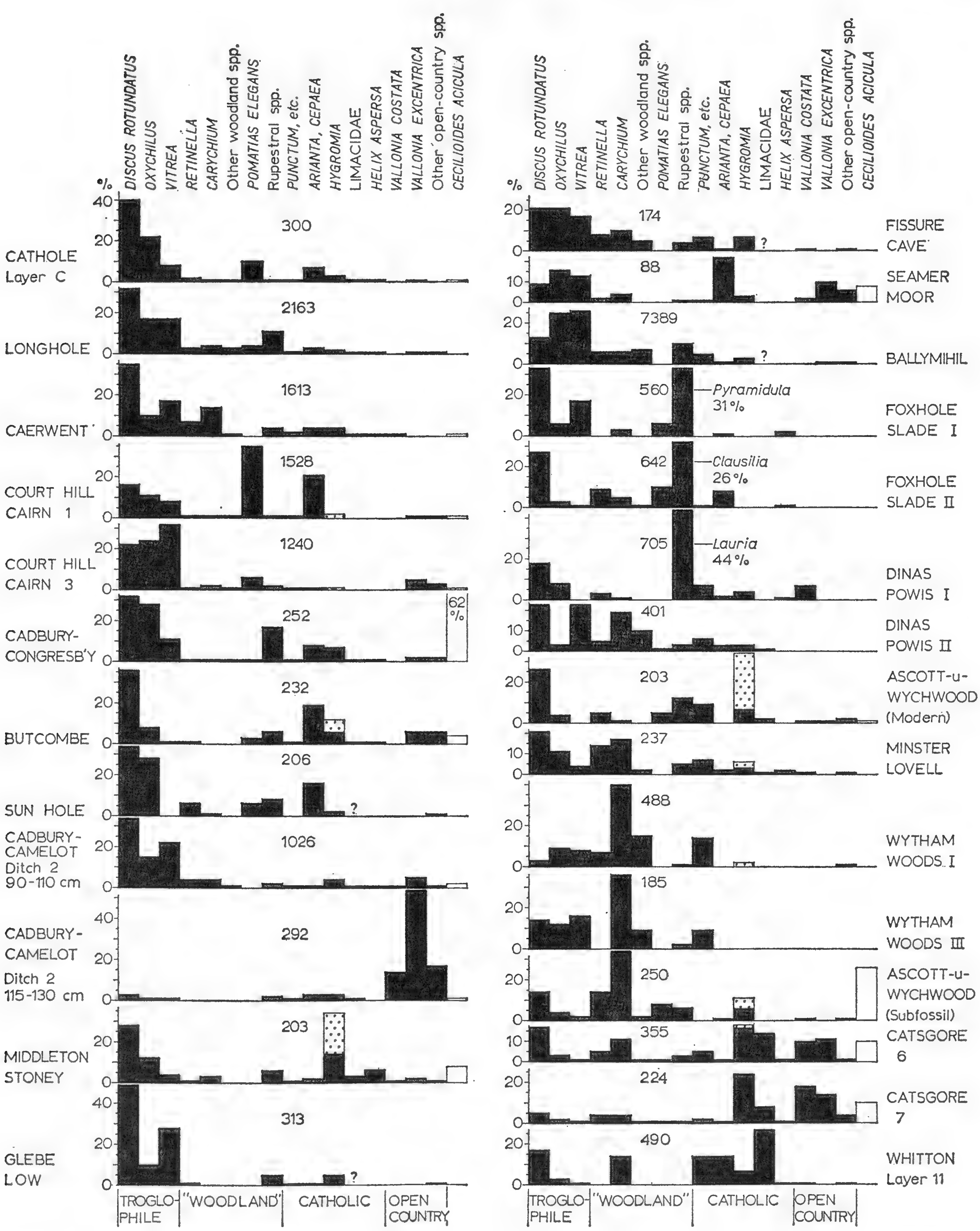

Fig. 3. Representative faunas from rock-rubble and other habitats. "*Punctum, etc.*" includes *Euconulus fulvus, Retinella radiatula, Vitrina pellucida* and *Cochlicopa*.

Court Hill Cairn, Somerset (ST 437722)

The Court Hill Cairn is a Bronze Age round barrow, excavated by Mr. H. S. Green in 1969 on behalf of the M5 Research Committee. It is situated on the Failand Ridge—a ridge of Carboniferous Limestone about 8 km. north of Cadbury-Congresbury. The limestone is overlain by at least 0·5 m. of gravel on the site but it outcrops 65 m. to the south-east. The cairn is composed of large and small blocks of limestone brought to the site from outcrops probably nearby, and it is this which has created a favourable habitat for many species of snail.

Three samples were analysed as follows:

Sample	
1	Cairn material + some shells hand picked
2	Grave fill
3	Soil among bones (burial horizon)

All weighed approximately 2·0 kg.

The assemblages from each are similar (Fig. 3), and typical of rock-rubble habitats. That from the grave fill is the most characteristic, with *Discus* as the predominant species. The fauna from the burial horizon contains *Oxychilus cellarius* and *Vitrea contracta* in extraordinary abundance, each outnumbering *Discus*, and in this respect it differs from most of the others discussed in this paper. Both *Oxychilus* and *Vitrea*, as well as being able to live in underground cavities, are facultative flesh-eaters, and their abundance in the grave is probably to be attributed to this fact, the animals having been attracted to the decaying corpse. The fauna from the cairn material is characterised by large numbers of *Pomatias elegans* and *Cepaea nemoralis*, a feature which may in part be due to the hand-selection of many of the shells.

Cadbury-Congresbury, Somerset (ST 442650)

The site is an Iron Age hillfort, re-occupied and re-fortified in the Dark Ages (*c*. 430 to early 6th century A.D.). The current excavation is being done by the University of Bristol Department of Extra-Mural Studies under the direction of Mr. P. J. Fowler, Mr. K. S. Gardner and Mr. P. A. Rahtz. The site lies on the western end of a spur of Carboniferous Limestone, north of the main Mendip range. Drift cover is absent.

A number of soil samples examined were poor in or totally devoid of shells, but one, weighing 3·0 kg., from a small cairn of post-Roman age, yielded a countable quantity. The age of the assemblage is probably 5th to 6th century A.D.

The assemblage (Fig. 3) is similar to that from Butcombe (see below) but more characteristic of rock-rubble habitats in the abundance of *Vitrea* and the paucity of open ground species. *Cecilioides acicula* is abundant.

Butcombe, Somerset (ST 508631)

The site is a settlement of Romano-British date, being currently excavated by

Mr. P. J. Fowler for the University of Bristol Department of Extra-Mural Studies with the Bristol Archaeological Research Group. It is situated at about 170 m. O.D. on a gentle slope in the upper reaches of a tributary of the River Yeo. The geological solid is Carboniferous Limestone; drift cover is virtually absent, though there are occasional patches of clay.

Of the seven samples analysed, only one yielded sufficient shells for counts to be worthwhile. In the others, shells were either extremely sparse or absent altogether. The reason for this is probably the slow rate of weathering of Carboniferous Limestone, resulting in soils which are generally non-calcareous (Evans, 1972: Fig. 64). It was noticeable that the horizons which were devoid of shells were *in situ* soils buried beneath flagstone floors or the walls of buildings, while the one horizon which yielded shells in any quantity was tumbled wall débris.

The sample analysed weighed 5·0 kg., and came from the base of tumbled stone rubble deriving from the main enclosure wall. Although ostensibly 4th century A.D. in age, many of the shells may be of later origin.

The fauna (Fig. 3) is similar to others from such habitats in the high abundance of *Discus* (36%) relative to *Carychium* (0%), the predominance of *Oxychilus* (8%) over *Retinella* (1%) and of *Vallonia excentrica* (6%) over *V. costata* (0%). Unusual, is the virtual absence of *Vitrea*, a feature matched only at Sun Hole in the subfossil faunas from true rock-rubble habitats, and there probably due to collecting deficiencies. At Butcombe, however, the reason is probably an ecological one and must for the moment remain a mystery. Faunas from similar habitats at the nearby sites of Court Hill Cairn and Cadbury-Congresbury are rich in *Vitrea*.

Sun Hole Cave, Cheddar (ST 467541)

Lists of shells from late Pleistocene deposits in this cave are given by Davis (1953–1956). The lists from six levels (covering a vertical height of six feet) have been combined and presented in histogram form in Fig. 3. *Arion* granules and two shells of *Helicella caperata*—the latter being considered by Davis to be intrusive—have been excluded.

The material from which the shells derive is a solifluction deposit of angular gravel with comparatively little admixture of fine earth. It is suggested on faunal (Mammalia) and archaeological grounds to be of Late-glacial age (pollen zones II and III), containing an Upper Palaeolithic industry of Cheddarian type (Tratman, 1962–1965). The snail fauna, however, is clearly Post-glacial in age, being dominated by *Discus rotundatus*, *Oxychilus cellarius* and *Cepaea nemoralis*, none of which occur in the Late-glacial. It thus appears that, as at Cathole and Longhole, we have here a snail fauna which is living in the interstices of rock rubble and which is not coeval with its deposition in the first place. The fauna differs from most rock-rubble assemblages in the high abundance of *Retinella* (6%) and the absence of *Vitrea*, but this may be a function of the way the shells were collected—as is suggested by the abundance of *Cepaea*.

Catsgore, Somerset (ST 506265)

The site is a Roman farmstead, excavated by Mr. R. H. Leach on behalf of the Department of the Environment and the Somerset and Yeovil Archaeological Societies. It lies mid-way between Somerton and Ilchester at a height of *c.* 40 m. O.D., and is about 11 km. west of Cadbury-Camelot. The geological solid is Lower Lias clay, and this is overlain by a thin layer of small limestone rubble. The site has been made more suitable as a habitat for land snails by the importation of blocks of Liassic limestone for use in the construction of the farm buildings.

Three samples from rock rubble habitats were analysed as follows:

Sample	*Provenance*
4	Earth floor of a late 4th century building
6	Shell-rich horizon in the fill of a late-Roman gully
7	Unprovenanced sample from earth and rock rubble, being collapsed building débris

Each sample weighed approximately 1·0 kg.

The faunas (Fig. 3) differ from characteristic rock-rubble assemblages in the abundance of the open ground element (largely *Vallonia*) and it must be assumed that on this site the interstices of the rock rubble became rapidly infilled with soil soon after deposition, not preserving the open network so characteristic a feature of the other sites. This may be a function of the softer nature of the Liassic limestone.

Cadbury-Camelot, Somerset (ST 626250)

The site is an Iron Age hillfort situated in south-east Somerset on the edge of the Jurassic limestone, with a spectacular view over two-thirds of the county. The ramparts traverse the junction of the Upper Lias (Yeovil Sands) and Inferior Oolite. The hillfort was sacked by the Romans during the first century A.D., after which it lay derelict for about two hundred years (Alcock 1972). It is probably from this period that the snail faunas described here derive.

A section through the defences on the southern side of the hillfort revealed a series of earth and rubble deposits infilling the ditches, and two samples from rock-rubble situations in ditches 1 and 2 (both from noticeably shell-rich horizons) were analysed. In addition, a sample from the primary fill of each of the ditches was analysed, the latter coming from below the rock-rubble layers in both instances.

Ditch 1	*Weight of sample* (*kg.*)
Shell layer	1·5
Primary fill	2·2
Ditch 2	
90–110 cm. below surface (shell layer)	0·7
115–130 cm. below surface (primary fill)	1·0

It was at this site that the problem of these rock-rubble faunas first arose. Thus the primary fill of ditch 2 (115–130 cm.) contains abundant *Vallonia* and *Helicella itala*, with *Pupilla muscorum* present up to 6% (Fig. 3). By analogy with sites on chalk, the rock rubble horizon above this material (90–110 cm.) would be expected to contain a fauna of yet more open facies but this, as can be seen from Fig. 3, is clearly not so. Of the open-country species all but *Vallonia excentrica* fall to less than 1% while the "woodland" element—*Oxychilus, Vitrea* and *Discus*—comes to dominate the fauna.

The fauna from a rock-rubble layer in ditch 1 (shell layer) was similar. The primary fill of ditch 1, however, contained a fauna of greater "woodland" facies than that from the corresponding layer in ditch 2. It has been included here because although clearly related to true rock-rubble faunas in the predominance of *Discus, Oxychilus* and *Vitrea* (and very little else), it is remarkable in the high value (20%) for *Lauria cylindracea*. Nowhere else on this site (and several situations were investigated) was *L. cylindracea* present at more than 1%. We have grouped the species with the rupestrals, and it appears to be a characteristic of this group that they sometimes occur in extraordinary abundance, often in quite a small locality. A similar phenomenon was observed at Foxhole Slade and Dinas Powis I (Fig. 3).

Ascott-under-Wychwood, Oxon. (subfossil) (SP 299175)

The site is a Neolithic long barrow, excavated by Mr. D. G. Benson for the Department of the Environment and the Oxford City and County Museum, between 1965 and 1969. It lies in the Oxfordshire Cotswolds at *c.* 120 m. O.D. on the side of a tributary of the River Evenlode. The geological solid is Oolite limestone.

A sample (2·15 kg.) of stony dark-brown loam from a buried soil in the fill of one of the quarry ditches from which the barrow was built was analysed for land snails. The age of the soil is 2nd or 3rd millennium B.C.

The fauna (Fig. 3) is included here as an example of a woodland assemblage from a limestone site, *not* deriving from a rock-rubble habitat, but in all probability from a woodland floor. Thus *Carychium* and *Retinella* are noticeably abundant by comparison with their general scarcity in rock-rubble faunas, and in this respect the assemblage compares well with some of those from Wytham Woods, also a woodland floor habitat (Fig. 3).

Middleton Stoney, Oxfordshire (SP 534233)

The site is a motte-and-bailey castle, situated on level ground immediately to the south of the present-day village. It is currently being excavated by Dr. T. Rowley for the Oxford University Department of External Studies.

The geological solid is Cornbrash limestone which gives rise to deep brown-earth soils of neutral or barely calcareous reaction. However, the building of the castle, entailing considerable quarrying operations into the Cornbrash, has locally upgraded the lime content of the soil thus bringing about a richer molluscan fauna

than would have otherwise been the case. In addition, the creation of a third dimension to the environment—stone walls, sheltered ditches and the huge motte of the castle—has resulted in numerous favourable habitats for snails (cf. Caerwent and Catsgore).

A sample (1·0 kg.) was taken from stone rubble at the base of a medieval wall and analysed for snails. The wall was built over the fill of the inner bailey ditch and sealed to a depth of 70 cm. by a further accumulation of stone and earth.

The fauna (Fig. 3) is similar to others from such habitats, notably that from Caerwent. The only anomalous feature is the high abundance of both *Hygromia hispida* and *H. striolata* relative to other rock-rubble sites. It is possible that one of the essential requirements for *H. hispida* is an environment where the soil moisture content remains high throughout the year. *H. hispida* is noticeably more abundant at Whitton where the environment was permanently damp, and at Catsgore where grassland is indicated by the prevalence of *Vallonia* spp. This would imply that *H. hispida* could only live in rock-rubble habitats when there was a high concentration of earth amongst the stones thus buffering marked moisture (and temperature) changes in the atmosphere.

The abundance of *H. striolata*, on the other hand, is probably due to the age of the fauna rather than to any intrinsic properties of the habitat. Today, *H. striolata* is abundant in rock-rubble habitats, particularly when associated with human interference, and the real problem is not so much its abundance at Middleton Stoney, but its paucity at other sites. It has been shown that *H. striolata* was once common in woodland during the earlier part of the Post-glacial, and it is probably present in just such a context in the subfossil fauna from Ascott-under-Wychwood (see above). Later on, however, it seems to have forsaken this type of habitat and come to live as a synanthropic species (Kerney, 1966). When this change took place is not certain, but it would appear from a consideration of the faunas discussed in this paper, many of which are Iron Age or Roman, that it was not until after the end of the Roman occupation (i.e. post 5th century A.D.).

Glebe Low, Great Longstone, Derbyshire (SK 204732)

The site is a Bronze Age barrow, situated on Carboniferous Limestone. A soil sample from an undated secondary burial inserted into the barrow was analysed for shells by Mrs. N. F. McMillan (Radley, 1966) and a typical rock-rubble fauna obtained (Fig. 3).

Fissure Cave, Hartle Dale, Derbyshire (SK 165803)

The site is a cave in Carboniferous Limestone. Faunas from deposits near the entrance have been described by Mrs. S. Turk (1963–1966). Most, if not all, of the six samples examined derive from, or can be correlated with, a single layer, layer 3, which occurred at a depth of from 2·0 to 2·3 m. below the surface and comprised a yellowish clay with small fragments of calcite and limestone, plus limestone rocks and boulders. Its age is thought to be late Neolithic or Early Bronze Age.

The six assemblages (excluding *Arianta* and *Cepaea* spp. whose abundance may be in part due to hand picking) have been amalgamated and presented graphically in terms of relative abundance (Fig. 3). Although in a typical rock-rubble situation, the shells are considered by Mrs. Turk to derive from material brought down by rainwashing from wooded slopes above the cave, and not to be the remains of an *in situ* fauna. This would certainly accord with the composition of the fauna which has a much greater abundance of *Retinella* and *Carychium* than is normal for rock-rubble faunas.

Seamer Moor (East Barrow), Yorkshire, N. Riding (TA 001864)

The site is a Neolithic round barrow, excavated by Mr. D. D. A. Simpson for the Department of the Environment. It lies at 100 m. O.D. on drift-free Corallian limestone, overlooking the Vale of Pickering. The mound is made up largely of limestone rubble, together with some larger blocks, all of local origin.

A sample (2·0 kg.) of rubbly material from near the base of the mound, at a depth of 1·3 m. below the surface, was analysed. Snails were few, but the fauna (Fig. 3) is clearly similar to those from other rock-rubble habitats. Among the Zonitidae, *Oxychilus* and *Vitrea* predominate. *Discus rotundatus* is in greater abundance than *Carychium,* and *Vallonia excentrica* (10%) predominates over *V. costata* (1%). The high percentage of *Arianta* and *Cepaea hortensis* is due to the inclusion of a number of hand-picked specimens and is probably not a measure of their true abundance in the fauna.

The abundance of *Discus* is low by comparison with other sites of this kind. This is possibly due to the site being in eastern England, and thus suffering a less oceanic climate than those in the west. *D. rotundatus,* although generally distributed in the British Isles, is often rare in eastern counties, and its distribution in Europe as a whole is markedly western.

Ballymihil Cave, Co. Clare (O.S. Clare 6-in. sheet 5, S. 3·3 in. E. 4·6 in.)

A rich fauna from Ballymihil Cave was described by Williams and Williams (1966) and tentatively ascribed to the Atlantic or Sub-boreal periods of the Post-glacial. The deposit comprised angular limestone rubble (20%) in a matrix of in-washed calcareous boulder clay and organic remains.

The molluscan fauna is presented graphically in Fig. 3, and is seen to have affinities with others from rock-rubble habitats. However, *Retinella* and *Carychium,* as at Fissure Cave, are present each at 5%, and the catholic species are unusually abundant for such faunas. Williams and Williams consider the shells to have been washed into the back of the cave from outside and, as at Fissure Cave, to derive from a woodland environment. A number of differences from the present-day fauna are cited, notably the paucity of rupestral species—*Pyramidula* and *Lauria*—in the subfossil assemblage and the abundance of *Discus, Oxychilus* and *Vitrea,* these differences being ascribed to the disparity in age of the two faunas. However, while not disputing that such a disparity exists, it is to be pointed out that the differences may be a reflection of different environments,

the subfossil fauna, in part at any rate, deriving from a rock-rubble habitat where rupestral species are generally rare.

MODERN SITES

Foxhole Slade, Glamorgan (SS 439859)

Foxhole Slade is a small dry valley in Carboniferous Limestone on the south coast of the Gower Peninsula, situated 1·6 km. north-west along the coast from Longhole. At its junction with the cliff lies the famous Paviland Cave.

The sides of the dry valley (Plate 1) are generally free of trees and present three distinct types of habitat. First there are cliffs on which rupestral species such as *Lauria cylindracea* and *Pyramidula rupestris* thrive in hundreds. Then there are areas of short-turfed grassland kept closely cropped by sheep. The fauna of these consists largely of *Vallonia excentrica* and species of *Helicella*, again in abundance. Finally there are areas of limestone scree and it is the faunas of these which are of most interest in the present context. Two samples were analysed for snails. One (Foxhole Slade II) consisted largely of leaf litter and came from an area in which plants were present—a situation which, apart from the total absence of trees, was similar to that at Minster Lovell and Dinas Powis II. The other sample (Foxhole Slade I) came from an area about 20 m. away in which vegetation was absent, and consisted largely of soil. The differences between the two faunas are remarkable and provide an important clue to the understanding of the subfossil faunas already described.

In Foxhole Slade II (Fig. 3) the predominant elements are *Discus rotundatus* and *Clausilia bidentata*. *Retinella* is in excess of *Oxychilus*, and *Vitrea* is virtually absent. *Carychium tridentatum* constitutes 5%. In other words this is not a typical rock-rubble fauna.

Foxhole Slade I, on the other hand, while again dominated by *Discus*, contains abundant *Vitrea* (17%), with *Oxychilus* at 6%, but with no *Retinella* at all. Here we have one of the closest modern parallels to our subfossil rock-rubble faunas, and the critical factor in controlling its composition is clearly the absence of any form of vegetation in the habitat. It is interesting to note too the total absence of open-country species, when not three metres away they are predominant in grassland. The presence of "woodland" species in a landscape which could not be more open is a vindication of the ascription of these rock-rubble faunas to habitats in which the micro-environment is paramount in controlling their composition.

Dinas Powis I, Glamorgan (ST 153716)

The site is a medieval castle, sited on a knoll of Carboniferous Limestone, and lies about 1·0 km. south-east of Dinas Powis II.

The habitat investigated comprised a 60 cm. pile of rock rubble at the base of the castle wall. There was also a quantity of rubbish in the form of broken

glass and pieces of corrugated iron, and the site was evidently strongly influenced by the presence of man. It was also shaded by elder bushes.

A sample, largely of leaf litter and fine stone rubble, was analysed for snails. The fauna (Fig. 3) is dominated by *Lauria cylindracea* and in this respect is not typical of the subfossil rock-rubble faunas described above. In other ways too—the absence of *Vitrea* and the abundance of *Retinella*—this fauna is atypical, and these differences are to be explained perhaps by the profusion of leaf mould in the habitat.

Dinas Powis II, Glamorgan (ST 146723)

The site is a narrow gorge in Carboniferous Limestone, which lies immediately to the west of the Dinas Powis hillfort. The sides of the gorge are wooded, and in places there are areas of scree.

A sample of leaf litter and soil from amongst the rock rubble yielded a fauna (Fig. 3) dominated by *Discus rotundatus*, *Vitrea* and *Carychium tridentatum*. Other woodland species—*Acicula fusca* and *Acanthinula aculeata*—amount to 10%, and *Retinella* is in greater abundance than *Oxychilus*. Thus in spite of certain similarities, the fauna is not typical of rock-rubble habitats, a feature probably to be attributed to the high moisture-retaining capacity and leaf-mould content of the soil at this site.

Ascott-under-Wychwood, Oxfordshire (*modern*) (SP 299175)

The snail fauna from rock rubble at the base of a collapsed wall, about 20 m. to the west of the long barrow site (Ascott-under-Wychwood (subfossil)), was investigated. A count was made on the site, and a sample of leaf litter and soil from the base of the pile analysed in the laboratory. The results of these two counts showed no significant differences and have been treated as one.

The fauna is not typical of rock-rubble habitats, the only characteristic species occurring in any abundance being *Discus rotundatus*. *Retinella* is slightly more abundant than *Oxychilus,* while *Vitrea* is entirely absent. The abundance of *Hygromia striolata* by comparison with its general sparsity or absence from rock-rubble faunas is possibly a function of the age and the synanthropic character of the habitat, as discussed in the case of Middleton Stoney.

Minster Lovell, Oxfordshire (SP 315111)

The snail fauna from a tree-shaded limestone scree above the south bank of the River Windrush was investigated. On the site, *Hygromia striolata,* as at Ascott-under-Wychwood, was noticeably abundant, as were, to a lesser extent, *Cepœa hortensis, C. nemoralis, H. aspersa* and *Discus rotundatus*. A sample of soil and leaf litter was taken from 15 to 30 cm. below the rock rubble surface and analysed for snails.

Again, as at Ascott-under-Wychwood, certain differences from true rock-rubble assemblages are apparent, notably the abundance of *Retinella* by comparison with the paucity of *Oxychilus* and *Vitrea* (Fig. 3). And the fauna differs further in the

abundance of *Carychium*, suggesting a moister habitat than obtained in most of the subfossil rock-rubble sites.

Wytham Woods, Berkshire (SP 463081)

Mason (1970) describes faunas from beech woodland from four sites in Wytham Woods. They have been included here as examples of faunas occurring in shaded habitats on limestone which are not in the rock-rubble category. The site is virtually level, and there is a well-developed soil overlying the Corallian Limestone.

Two of the faunas have been presented graphically (Fig. 3), and their most obvious characteristic which sets them apart from rock-rubble faunas is the predominance of *Carychium tridentatum*. In addition, the faunas can be classified on the basis of whether or not *Retinella nitidula* and *R. pura* are present, and there is a correlation here with the quantity of leaf litter in the habitat. Thus at sites 1 and 2 where there is abundant litter, both species of *Retinella* occur; at sites 3 and 4 where litter is thin or absent, neither species occurs. These trends are similar to those seen in the two sites at Foxhole Slade.

THE FAUNAS

The molluscan faunas are made up of four broad ecological groups, namely the troglophile, "woodland", catholic and open-country species.

Troglophile species

Troglophile species are those which are frequent in caves and other underground places but which are not confined to them (Vandel, A., 1965). As far as it concerns the faunas from rock-rubble and scree habitats described in this paper, *Discus rotundatus*, *Vitrea* and *Oxychilus* are the most abundant and most characteristic. The species of *Vitrea* is generally *V. contracta*, though *V. crystallina* occurs on occasion but never in abundance. On some sites, particularly those in the west, the shells of *V. contracta* approached those of *V. crystallina*, mainly in the form of the umbilicus. Once this had been realised, however, most specimens could be identified with confidence, there being no question of a graded series between the two species. *Oxychilus* is generally represented by *O. cellarius*, though *O. alliarius* and *O. helveticus* are present on some sites. Some of the specimens of *Oxychilus* were enormous, being up to 15 mm. in diameter, far beyond the usual 10 mm. for *O. cellarius*. Nevertheless there were only two possible examples of *O. draparnaldi*, the others clearly being the large form of *O. cellarius* recorded from other sites in the west of Britain.

The key to the abundance of these three groups is their marked capacity for living in places devoid of vegetation. *Oxychilus* and *Vitrea* are known flesh-eaters, as presumably is *Discus*, though there is little mention of the latter in the literature. All three, and particularly *Oxychilus* and *Discus*, are constantly recorded from subfossil faunas in caves; e.g. *Oxychilus cellarius* is "... particularly common in all cavern deposits ..." in Ireland (Kennard & Woodward, 1917).

As far as we know, there has been no study of the modern molluscan faunas of caves in Britain. In Europe, however, a number of such studies have been made, and these show that *Oxychilus cellarius*, *Discus rotundatus* and *Vitrea* are generally the predominant species. Vandel (1965 : 74) in his general work on the biology of cavernicoles notes that in the Gastropoda, the Zonitidae is the family containing the majority of species to occur in caves, and that the main genus is *Oxychilus*. In Belgium (Leruth, 1939; Boettger, 1939) *O. cellarius* is the commonest cave-dwelling species (24 sites) followed by *Discus rotundatus* (18 sites). There is only one site known for *Retinella pura,* while *R. nitidula,* though present in Belgium, is not recorded from caves. *Vitrea crystallina* occurs on one site. In the Ariège Department of southern France (Coiffait & Soyer, 1965), out of 31 sites, *Oxychilus draparnaldi* is present at 12, *O. alliarius* at seven, *Vitrea crystallina* at five and *Discus rotundatus* at four, all being abundant or common in each case. *Retinella pura* is present at two sites and *R. incerta* at one; both are rare. With the exception of *Vitrina pyrenaica* (three sites, abundant to rare) and *Acme dupuyi* (six sites, abundant to common) all other species are present at only one or two sites and are always rare. In Switzerland, too, a similar pattern obtains (Strinati, 1966). *Oxychilus cellarius* is recorded from 20 sites, *O. helveticus* from six, *O. draparnaldi* from two, *Discus rotundatus* from 12 and *Vitrea contracta* from one. *Retinella* and *Carychium* are not represented at all, and most others occur in only one or two sites.

There is no doubt that *Oxychilus cellarius* can and does eat animal matter both alive and dead, references to this habit being common in the literature (e.g. Boycott, 1934: 3). Tercafs and Jeuniaux (1961) measured the chitinase activity in the stomach contents and hepatopancreas homogenates of *O. cellarius*, and found that the level of activity was much higher than that in strictly phytophagous species such as *Helix pomatia*. *O. cellarius* is thus suited to a cavernicolous diet and has been able, in common with other species of the genus, to colonise the subterranean environment. It should perhaps be pointed out that above ground, *O. cellarius* can exist quite satisfactorily on vegetable matter, its presence in underground faunas being one of choice, not necessity (Tercafs, 1961).

Cœcilioides acicula

The "woodland" species *sensu lato* are a heterogeneous group ecologically. The term was originally applied by Boycott (1934) to include all those species which generally require moisture and shade, and although many are able to tolerate non-woodland habitats, the term is a useful one and has been retained here.

Most characteristic are *Retinella pura*, *R. nitidula* and *Carychium tridentatum* (*C. minimum* at Ballymihil), species which are generally common in woodland faunas from chalk and limestone sites, where *Carychium* is often the most abundant species. This is well shown in the faunas from Ascott-under-Wychwood (subfossil) and Wytham Woods which are normal woodland sites. The modern faunas from tree-shaded scree habitats at Minster Lovell and Dinas Powis II are

also characterised by high *Carychium*, and, by comparison with *Oxychilus*, high *Retinella* percentages.

In contrast, true rock-rubble and scree habitats where vegetable mould is sparse are generally poor in these three species. *Retinella nitidula* and *R. pura* do not share the carnivorous habit shown by other genera of the Zonitidae (Boycott, 1934: 3)—notably *Oxychilus* and *Vitrea*. *Carychium*, too, is generally most abundant in leaf litter in woodland or at the base of grasses in tall ungrazed grassland, suggesting a preference for plant food. Certainly its paucity or absence from rock-rubble habitats, in which the humidity is by no means low, is difficult to explain in terms of an unfavourable moisture regime.

There are also many species which generally occur in woods but which are rarely present in sufficient abundance to make separate plots meaningful. As a whole, however, they may make up a sizeable component of the fauna. They have been plotted as "other woodland species". In the case of rock-rubble habitats the group rarely occurs at greater than 10% abundance (Cadbury-Congresbury, 11%; Longhole, 15%, Dinas Powis II, 13%) and appears to be more characteristic of true woodland habitats, often fluctuating in sympathy with *Retinella* and *Carychium* (Fig. 2).

The species are *Acicula fusca*, *Columella edentula*, *Vertigo pusilla*, *V. substriata*, *Lauria anglica*, *Acanthinula aculeata*, *A. lamellata* and *Monacha granulata*. A number are generally rupestral, but these almost always occur in shaded places such as the undersurface of logs. The more characteristic rupestrals are considered below.

The "woodland" species, *Pomatias elegans*, has been plotted separately in Figs. 2 and 3. It is sporadic in its occurrence, and seldom comprises an important element of the faunas. Exceptions are Court Hill Cairn (up to 35%, though possibly caused by hand-picking), Sun Hole (6%, but again hand-picking is likely), Longhole (4%), Cathole (up to 18%) and Foxhole Slade I and II (6% and 10%).

The absence of this species from some of the sites is due to their being outside its range in Britain which is markedly southern (Kerney, 1968: Fig. 3). Thus it is absent from Ireland and Derbyshire, is extremely rare in Yorkshire, and in the north Cotswolds and Oxfordshire is only occasionally present.

Its absence from sites well within its range may be due to human interference (of which *P. elegans* is generally intolerant), and although some of the sites may now be suitable for the species, its inability to colonise freshly created habitats probably explains its absence from Caerwent, Whitton, Cadbury-Camelot and Dinas Powis I. In other words, the abundance of *P. elegans* is controlled not only by the immediate characteristics of the habitat, but by climatic and historical factors also.

The rupestral species are those "woodland" species which characteristically live on rocky surfaces such as cliffs and stone walls, and which can tolerate dryness, light and a wide range of diurnal temperature. They are *Pyramidula rupestris*, *Lauria cylindracea*, *Ena obscura*, *Marpessa laminata*, *Clausilia bidentata*, *Balea*

perversa and *Helicigona lapicida*, and with few exceptions are rare or absent from the sites discussed in this paper, thus emphasizing the very definite character of the rock-rubble habitat as being distinct from those favoured by rupestral snails.

The exceptional sites are Longhole, Cadbury-Congresbury, Foxhole Slade I and II and Dinas Powis I (Fig. 3). No satisfactory explanation can be given for the irregularities in abundance of these species, but it may be relevant that three of the sites just quoted are modern, and that no exact modern equivalent to the subfossil rock-rubble faunas has been found—the nearest parallels are rich in rupestral species. Williams and Williams (1966) pointed out the paucity of *Pyramidula* and *Lauria* in the Ballymihil Cave by comparison with their present-day abundance in the area, a difference which they ascribed to the age difference between the two faunas.

Catholic species

This group includes species which can tolerate a variety of habitats—marsh, woodland and open-country—and are not diagnostic or typical of a well-defined set of habitat conditions. In addition, the group includes a number of species—notably *Cochlicopa, Cepaea* and the Limacidae—which are difficult to identify with certainty and must be left at the generic level; their value in environmental reconstruction is thus limited. The species are *Azeca goodalli, Cochlicopa lubrica, C. lubricella, Arianta arbustorum, Cepaea hortensis, C. nemoralis, H. aspersa, Hygromia striolata, H. hispida, Monacha cantiana, Punctum pygmaeum, Euconulus fulvus, Retinella radiatula, Vitrina pellucida* and the Limacidae.

Hygromia striolata and *Helix aspersa* are synanthropic; otherwise the species show no special affinities for man-made habitats. The ecology of the group as a whole has been discussed recently (Evans, 1972).

In the present context, the most remarkable characteristic of the group, particularly those species which often favour shaded habitats (*Punctum, Euconulus, Retinella radiatula* and *Vitrina*), is their paucity or absence from many of the sites. *Hygromia hispida* and *H. striolata* are the best and most consistently represented, with *Helix* (*Cepaea*) and *Arianta* prominent at some sites; the abundance of the latter two, however, may have been caused by hand-picking. Otherwise, *Cochlicopa* and the Limacidae are well-represented at Whitton, and the Limacidae at Catsgore, both sites which are not strictly in the rock-rubble category. Finally, to press the point home, at Ascott-under-Wychwood (subfossil) and Wytham Woods—normal woodland sites—catholic species are abundant.

The reasons for the scarcity of this group in rock-rubble habitats are not clear. One possibility is that the environment is unsuitable for them in some way, perhaps in its low vegetable mould content, although this would not explain the absence of *Vitrina*, a species often prolific on bare surfaces, and a carnivore. The other possibility, is that the species which are well adapted to life in such habitats, do so in such great numbers as to exclude others not so suited. It is difficult to

make an objective assessment of the absolute abundance of particular species, but one is left with the impression, at any rate with *Discus* and *Oxychilus*, of unbounded profusion.

Open-country species

A marked characteristic of rock-rubble faunas is the paucity or absence of open-country species, even though the environment as a whole be bare of trees and shrubs. This has been most dramatically brought out at Foxhole Slade (Fig. 3, Plate 1), a site which strongly supports the ideas we have put forward regarding the interpretation of rock-rubble faunas as being controlled by the micro-conditions of the habitat.

At only two sites, Catsgore and Cadbury-Camelot, are open-country species at all well represented. The habitats at Catsgore presumably became infilled with soil and grassed over at an early stage, thus preventing the establishment of a true rock-rubble fauna. At Cadbury-Camelot, the open-country fauna is not from a rock-rubble habitat but comes from the fine infilling of a ditch, and has been included to indicate the dramatic contrast with that from the overlying layer of coarse limestone scree.

The open-country species are *Vertigo pygmaea*, *Pupilla muscorum*, *Abida secale*, *Vallonia costata*, *V. excentrica* and *Helicella*, generally *H. itala*, though *H. caperata* and *H. virgata* occur on occasion.

With the exception of Catsgore, where both are present in roughly equal numbers, only one of the two species of *Vallonia*, *V. excentrica* and *V. costata*, is generally present on any one site. Thus at Dinas Powis I and Whitton, only *V. costata* is present—up to 5% at Whitton, and 7% at Dinas Powis. On the other hand, *V. excentrica* is present alone at Ballymihil, Butcombe, Longhole, Cadbury-Congresbury and Court Hill Cairn at values of up to 12%, and predominates at Middleton Stoney, Seamer Moor and Cadbury-Camelot.

In reviewing the information on the ecology of *Vallonia* (Evans, 1972) it was pointed out that *V. costata*, while essentially a grassland species, can live in other habitats such as stone walls, woodland and places strongly influenced by man. In the case of Dinas Powis I and Whitton, its presence can probably be seen as a response to the anthropogenic nature of the habitats, both having been used as rubbish dumps and subsequently abandoned.

But the predominance of *V. excentrica* on many of the sites is more difficult to explain. From what is known of their ecology, *V. excentrica* almost never occurs in woods or other shaded places while *V. costata* may do so (Evans, 1972). Moreover, *V. costata* may also occur as a rupestral species, often thriving on stone walls. It is thus odd that in rock-rubble habitats where one might expect *V. costata* to be the predominant form, the species is not only rare or absent (with the exception of certain man-made habitats), but appears to be replaced by *V. excentrica* which one would not expect.

We have already pointed out that although superficial similarities exist between rock-rubble and rupestral habitats, bare rock surfaces being common to both,

basically they are different. Thus the fact that *V. costata* can occur on stone walls should not necessarily lead us to expect it also in rock rubble.

The problem therefore resolves itself into one of the response of the two species of *Vallonia* to shade.

The vast majority of sites studied are in the west of Britain where rainfall is higher and winter temperatures warmer than in the east. Could these differences in some way affect the habitat preferences of *V. costata* and *V. excentrica*? For example, although both species are wide-ranging in their distribution, occurring throughout Britain, and as far as 70° north in Scandinavia, *V. excentrica* is said to be the less cold tolerant of the two (Sparks, 1953), in which case it would perhaps be more suited to conditions in the west of Britain than in the east. It is therefore possible that, although *V. costata* appears to be the better adapted to extremes of temperature, where conditions are most suitable for *V. excentrica*, it can occur in a wider variety of habitats, and in so doing, may exclude *V. costata* by some form of competition. A similar suggestion has often been put forward to explain the antipathetic distribution of *Cepaea hortensis* and *C. nemoralis* in certain downland and sand-dune areas (e.g. Cain & Currey, 1963).

Cæcilioides acicula

C. acicula is a burrowing species, always living underground and often going down to 1·5 m. below the surface wherever the texture of the soil allows (Evans, 1972 : Fig. 55). It is unpigmented, and without eyes. Like certain cave-dwelling animals, and in contrast to the normal situation in land snails, it lays only one egg at a time (Wächtler, 1929).

Many of the examples from the sites discussed here were living; others were dead and in a subfossil state, having opaque shells often filled with sediment. Although some of the shells may be contemporary with the subfossil faunas with which they are associated, others may be much younger, and in no case is their age absolutely clear. In view of this the shells of *Cæcilioides* have been excluded from the totals and plotted as an open graph (Fig. 3) as a percentage over and above the rest of the fauna.

One would certainly not expect *C. acicula* to constitute an element of the rock-rubble faunas as, although both are essentially living underground, the textures of the habitats—soil in one case, vacuous rock-rubble in the other—are entirely different.

The faunas—Discussion

With reference to the relative abundance of each of the ecological groups described above, a number of faunas can be recognised.

First of all there are those in which troglophile species predominate, all other groups or species being at a minimum. These are the true rock-rubble faunas, and they reflect an environment in which vegetable mould is virtually absent. Cathole (layers C and D), Court Hill Cairn 3, Sun Hole, Cadbury-Camelot (shell layers) and Glebe Low (Fig. 3) fall into this category.

Two variants of this fauna are those in which rupestral species alone comprise a sizeable component of the fauna (Longhole, Cadbury-Congresbury, Foxhole Slade I and Dinas Powis I) and those in which synanthropic species predominate (Butcombe, Middleton Stoney).

At the opposite extreme are true limestone woodland faunas in which *Carychium* and/or *Retinella* are important elements. Here, leaf litter is essential in the habitat. Wytham Woods and Ascott-under-Wychwood (subfossil) are in this category. At Wytham, the presence or absence of *Retinella* appears to be controlled by the abundance or paucity of leaf litter on the woodland floor. Where leaf litter is sparse, the faunas tend towards those of rock-rubble type, though still maintaining a high abundance of *Carychium*.

Intermediate between true rock-rubble and true woodland faunas are some in which *Retinella* and *Carychium* are present in considerable abundance, though generally less prominent than the troglophiles. Cathole (layers E and F), Caerwent, Fissure Cave, Ballymihil, Foxhole Slade II, Dinas Powis II and Minster Lovell are sites with this type of fauna. We presume that these faunas are from essentially rock-rubble habitats (and in the case of the modern sites we know that this is so), but that leaf litter is present in sufficient quantity to enable non-carnivorous species of snail to occur.

Finally, furthest removed from the rock-rubble faunas are those in which catholic species as a whole are important elements (Whitton) and those in which open-country species predominate (Catsgore). In both cases the ratio of earth to rock rubble in the habitat is probably high.

As well as the immediate physical and biological properties of the environment, we have suggested that factors such as climate and the history of a site may be of importance in controlling the composition of the faunas. This appears to apply particularly to *Pomatias elegans* and the two species of *Vallonia*.

ARCHAEOLOGICAL IMPLICATIONS

Subfossil snail faunas from uncompacted limestone rubble are unlikely to be contemporary with the deposits in which they occur, and in general will be of later origin. Unless a layer of limestone rubble is sealed by a deposit of more compact material such as soil or stalagmite, or is itself consolidated by carbonate precipitation into a breccia, the addition of shells to the limestone rubble may continue indefinitely, and in the case of sites such as Caerwent, Longhole and Cathole, has probably been doing so to the present day.

This should not, however, necessarily detract from the value of such faunas in environmental reconstruction since a sequence of change taking place on the surface may eventually be registered by vertical changes in the assemblages throughout the deposits. A similar principle applies to the interpretation of pollen spectra from soils (Dimbleby, 1961). But at the same time it must be appreciated that the origin of the assemblages in rock rubble may be twofold—one component

deriving from the surface by downwashing, earthworm and rodent activity, etc. (as in the case of pollen), the other from snails actually living *within* the deposit. Interpretation of the faunas in terms of events which have taken place at the surface must be made, therefore, against a background of the environment obtaining within the rock rubble itself.

The other important implication of these rock-rubble faunas is that their pronounced woodland facies cannot be taken to indicate either the immediate presence of woodland or its occurrence in the area as a whole. The faunas are simply a reflection of the environment created by rock rubble.

GENERAL CONCLUSIONS

The majority of faunas described in this paper are from limestone rock-rubble and scree habitats. In many of these, vegetable litter is sparse or absent, and the faunas often comprise species which are known to be (*Oxychilus* and *Vitrea*) or seem likely to be (*Discus*) eaters of flesh and other animal débris. In this respect they are similar to faunas from caves in various parts of western Europe.

The faunas are distinct from both those of rupestral type and those from leaf litter on a woodland floor, their composition probably being controlled by high and uniform humidity, the absence of marked diurnal changes in temperature, and the absence of vegetable litter.

Open-country species are generally absent or sparse. Where present, they can be considered either as contaminants, or as an indication of some degree of openness in the environment together with infilling of the crevices of the rock rubble with soil. In the case of *Vallonia costata* and *V. excentrica*, however, other factors appear to be operating, since one or other may occur in faunas from which all other open-country species are absent. It is thought that *V. costata* is favoured by habitats of rubbish-dump type while *V. excentrica* is favoured by the overall climatic conditions—high rainfall and mild winters—obtaining in the west of Britain.

The faunas are considered to be later than the deposits in which they occur, and to be a reflection of the local habitat conditions within the rock rubble—not of the overall environment. The implications of these facts in the interpretation of subfossil assemblages from archaeological sites on limestone have been discussed.

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J. Conch. **28**: 130 (1973)

REVIEW

Land Snails in Archaeology with special reference to the British Isles. By John G. Evans. Seminar Press London and New York. 1972. Price £7.90

The taste for snails is a limited one and books devoted to the subject have till now been mainly identification manuals, biological or taxonomic works. The use of these creatures in the detective task of inferring the conditions of the past has a long history, but many of the results are hidden away in appendices to other authors' papers in a variety of more and less obscure journals. There are certain classic summary ecological papers (notably Boycott's two in the 1930s) and a number of later summary and general accounts also published in journals. Now Dr Evans has provided a pioneer volume on the subject.

The book itself falls into a number of sections, the methods of working, the identification of the snails, the ecology of snails, the distribution of land snails in time and space, and a discussion of the various types of terrestrial deposits containing snails. There is a wealth of interesting information and a comprehensive list of references.

The book certainly goes beyond what the average practising archaeologist can be expected to know about snails and would seem to be most appropriate to archaeologists with special interests in snails and to conchologists primarily concerned with the application of their work to archaeological problems. It certainly should be widely available in general libraries and in all collections, archaeological, geological, and geographical, where the later part of the Quaternary is of interest. Its great value lies in the way in which the problems, the uncertainties and the complexities are continually stressed, so that even the non-specialist will have a good idea of the validity of what he is likely to learn from archaeological sections.

I hope that too many people are not seduced by Dr Evans' expertise into becoming do-it-yourself students of snail faunas without proper experience: the identification of bleached and broken Mollusca is not quite as easy as may be inferred. The excellence of his outline drawings of many species is greatly to be praised, but, if I remember my early years in identifying snails correctly, even the best illustrations are no real substitute for speciments and the intending expert will have to break specimens down to study their appearance in the youthful stages. And even then it is safest to have an expert check the identifications until he himself becomes an expert.

One only regrets that this work did not cover the whole field of the interpretation of Quaternary non-marine Mollusca, because most of the earlier Pleistocene faunas are largely freshwater. However, although I would have preferred such a work, it is not a valid criticism of Dr Evans' excellent book as he did not set out to write such an account.

B. W. Sparks

Foxhole Slade showing the three major habitats, cliffs, rock rubble and grassland.


Sincerely yours
H E J Biggs

J. Conch. **28**: 131–132 (1973)

OBITUARY

HERBERT EDWIN JAMES BIGGS 1895–1973

(Plate iv)

The need for writing an obituary on an old and very highly regarded friend brings a realisation that little can be said which does not sound more conventional than sincere. It must at least be said that his place in the Society and in the affections of many of its members was unique, and will not again be filled; the time he so generously gave to helping other people and the enthusiasm which marked him will not be forgotten. The impression which remains is of his young, expressive, happy face beneath the ample white hair, the feeling that he had sampled the World, learned much about it, liked what he had found, and especially humanity. When he smiled, as he so often did, the impression became a certainty. He rarely spoke much of himself, his interest in other people was too great for that, and there cannot be many of his friends who knew the full story of his eventful and satisfying life.

Herbert Biggs was born at Edmonton, Middlesex on July 16th 1895 and received education at the Enfield Grammar School. He was early interested in natural history, and founded his own museum at the age of twelve, with a section for the mollusca of Enfield, which he collected himself in areas now completely built-up.

On leaving school, he took a job in the offices of the Great Eastern Railway, but on the outbreak of War, joined the 7th Battalion London Territorials on September 14th 1914, went to France in March 1915 and was wounded at Festubert. He was commissioned 2nd Lieutenant in 1917 in the 10th (Duke of Wellington's) West Riding Regiment, was drafted to Italy the same year, and promoted 1st Lieutenant 1918.

Upon demobilisation in the spring of 1919, he returned to employment in the G.E.R., where he worked in the drawing office until September 1922, when a more adventurous life attracted him, he sailed for Persia with the Church Missionary Society, and became headmaster of the Kerman Boys' School for a period of two years. While there, he married Phyllis W. Cook in January 1924; she had travelled in the company of Persian muleteers across desert land from Bundar Abbas to Kerman for the ceremony, a remarkable journey for those days.

There followed a period of pastoral work for Bishop Linton in Isfahan from January 1925, but the autumn of 1928 found him back in England, studying at the London College of Divinity in preparation for his ordination, which took place the following year; he then returned to Persia as pastor of the Church at Kerman 1931–35.

A sojourn at Cairo then followed, where Biggs managed the business side of Arabic Christian Literature production, work which entailed travel in Palestine, Syria and the Sudan. In 1944, on his return to England, he became Rector of Mellis, Norfolk, and in 1948, Metropolitan Secretary for the United Society for Christian Literature until his retirement in 1960. This was retirement in name only, since he remained extremely busy in what he called "local work", involving the distribution of Christian literature and the taking of services in the district. In a letter received as recently as last December, he said "... confined to bed at present, and I've had to let somebody down for a promised service. There are still plenty of uses for an odd parson" : which illuminates his personality as well as any single remark could do.

He lost his wife in 1962, and late in 1963 he married Edith Constance Lewes of Aldeburgh, Suffolk, who he was wont to say, saved his life through most devoted nursing, when he was lying desperately ill in Cairo.

Shells remained Bert Biggs' study and delight all his life; he joined the Conchological Society in 1919 and was President in 1958–60. He was elected Fellow of the Linnean Society in 1956 and became an associate worker at the British Museum (Natural History) from 1960 to 1969. He also did much to lay the foundations of the European Malacological Union by becoming Secretary of the First European Malacological Congress in 1962. His death, which occurred on January 19th 1973, was due to a long-standing heart complaint.

By long study, Biggs had made himself an expert on the mollusca of the Near and Middle East, in particular those of the Persian Gulf, Red Sea, Eastern Mediterranean, and of the land areas round about them. He corresponded enthusiastically on the subject and was perpetually involved in discussions with, and identifications for, people all over the World. He also became very knowledgeable on archaeology. His capacity for hard work seemed almost inexhaustible, and the Society's Junior Section stands a monument to his foresight; he originated the Section and ran it to the end. It tended to languish for a while but his faith in its success never wavered and he produced a succession of new ideas for publicity, education and interchange. He was rarely absent from ordinary meetings of the Society, where no one could fail to notice his almost boyish enthusiasm and his readiness to help. He was too, on occasion, a perfect chairman, both during his term of presidency and at various meetings afterwards; always audible, and directing the proceedings with tact, firmness and humour. On more than one occasion he was able to dispel an atmosphere of considerable acrimony in a way which it was an education to watch.

His personality and his talents will be badly missed indeed.

T. E. Crowley

Mullusks.

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ON SOME GASTROPODS OF THE AEGEAN

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(Read before the Society, 18 November 1972)

ABSTRACT

The authors collected gastropods from the Greek islands of Tinos and Rhodes during July and August 1962. Thirty species of marine gastropods were identified; twenty-three from Tinos and twenty-three from Rhodes, of these sixteen were common to both islands. Six freshwater species were found; five confined to Tinos and the other with a different subspecies on each island. Eighteen terrestrial species were identified; eleven from Tinos and sixteen from Rhodes, of these nine were common to both islands. The species are listed and some comments are made on their ecology.

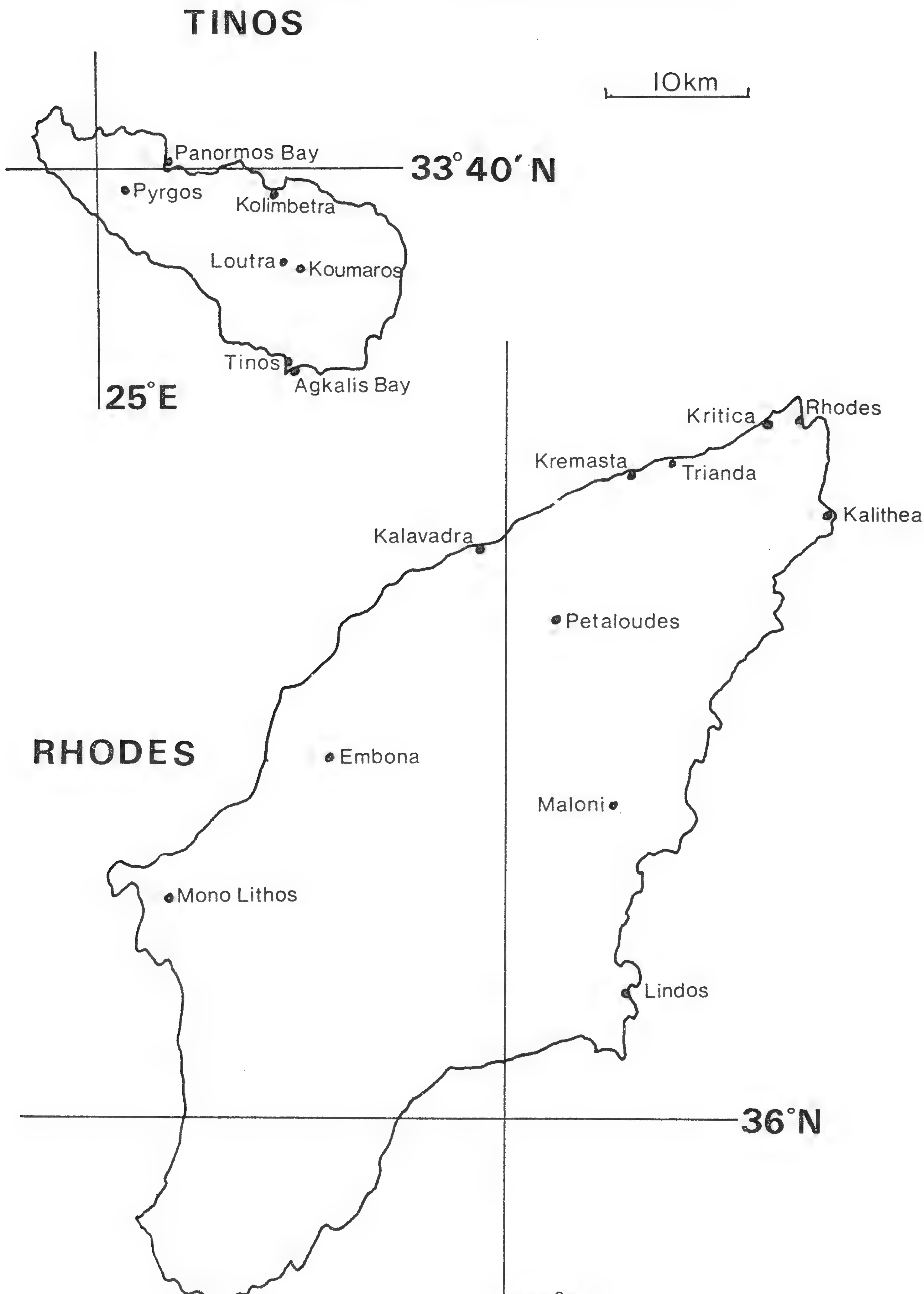
In July and August 1962 the authors made a collection of marine, freshwater and terrestrial gastropods while on an Oxford Women's Expedition to the Greek islands of Tinos and Rhodes. All the gastropods found have already been recorded in the Mediterranean area. They were identified using Bucquoy, Dautzenberg and Dollfus (1882–1898) and Eales (1960) for the marine species; Germain (1930 & 1936), Ehrmann (1936) and Zilch (1962) for freshwater and terrestrial ones, and using collections of the British Museum (Natural History).

There have been few publications on the molluscs of the area and Forbes' important pioneer work (1844) deals rather more with deeper-water zones. Paget has made a collection from Rhodes (Paget and Kritscher 1959, and Paget, personal communication). Huvé (1957) makes a preliminary report on the littoral zone at Cape Matapan in the Peloponnese.

MARINE GASTROPODS

In the Mediterranean the normal tidal variation is small; but wind, by affecting the size of the waves, influences the amount of shore submerged and the extent of zones. In sheltered bays the variation in water level was found to be only a few centimetres and even on exposed points only some fifty centimetres during fine weather. In stormy weather the variation was of course much more.

Huvé classified the zones of the littoral on the basis of studies at Cape Matapan; we used a simplified version of his classification, modified by our experience in the field.



Splash Zone (S.Z.)

This corresponds to Huvé's supralittoral and upper mesolittoral zones together. It is above water level but is frequently wetted by spray, either for several metres or for only a few centimetres depending on the amount of exposure. There are no large plants but there is usually a film of blue-green algae.

Intertidal Zone

This corresponds approximately to Huvé's lower mesolittoral zone, though it never extends, as his did, to a depth of 40cm.; and we did not find the *Vermetus* terraces which he found. We have divided it into:

Upper Intertidal Zone (U.Int.Z.): the upper 10cm. which were usually uncovered by wave action and had few plants.

Lower Intertidal Zone (L.Int.Z.): from 10 to 20 cms below the normal water level. It may occasionally be uncovered by waves, particularly on exposed points or during storms. Algae are more abundant in it and it grades into the infralittoral zone.

Infralittoral Zone (*Inf*.Z.)

This corresponds approximately to Huvé's infralittoral zone. It was considered to extend seaward from a depth of 20 cms and was searched to a depth of 50 cms.

The Localities sampled

TINOS ISLAND, MARINE (TM). Wind from the north in summer.

1. Agkalis Bay; facing south, fairly sheltered; mainly sandy but good algal growth on pebbles and boulders. Gastropods common.
2. Agkalis Bay; rocky shore with rich algal growth. Gastropods abundant except on red algae.
4. Agkalis Bay; sandy beach: no gastropods found.
6. Kolimbetra; facing north with large waves; sandy beach with some rocks but no algal growth and no animals.
14. Panormos Bay; facing north and exposed; large waves made the water turbulent and restricted searching and zones were not easily separated. Rocky shore with poor algal growth, mainly browns and reds. Few animals.

RHODES ISLAND, MARINE (RM). Wind mainly from the north-west during summer.

1. Rhodes town; facing east, fairly sheltered; weathered rocky shore near a slaughter house; the atmosphere was smelly and the effluent probably ran into the sea; poor algal growth of mainly browns and reds. Few animals.
2. Rhodes town; sand with slabs of sandstone with small tufts of mainly brown and red algae. Few gastropods.
3. Kritica; facing north west and very exposed; large waves impeded searching and no gastropods and few other animals were found in the sparse algae below water level.
5. Kalithea; facing east and fairly sheltered; rich algal growth but no gastropods were found below water level. As there is a Spa nearby the water may be chemically unsuitable.
7. Lindos Bay; facing east, a sheltered area outside the breakwater; shelving rock and some stones with abundant brown and red algae. Gastropods abundant.
8. St. Paul's Bay, Lindos; almost land locked so very sheltered bay, consisting

TABLE – MARINE GASTROPODA

Species Found	Size Range for Tinos and Rhodes in mm.	Splash Zone		Upper Intertidal Zone		Lower Intertidal Zone		Infralittoral Zone	
		Tinos	Rhodes	Tinos	Rhodes	Tinos	Rhodes	Tinos	Rhodes
Patella caerulea Linnaeus	8·9 – 48·5			++	++	+		+	
Monodonta turbinata (Born)	7·7 – 25·1	+		++	+++	+	+		
Gibbula divaricata (Linnaeus)	7·0 – 17·7		+	+	+		+		
G. rarilineata (Michaud)	9·6 – 10·4				+		+		
G. adansoni (Payraudeau)	2·0 – 9·6			+	+	+++	+++	++	++
G. richardi (Blainville)	2·5 – 18·2			++		+	+	+	+
Cantharidus striatus (Linnaeus)	5·3 – 7·1			+			+		
Tricolia pullus (Linnaeus)	6·8 – 11·2			+				+	
Littorina neritoides (Linnaeus)	3·2 – 10·1	+++	+++						
Rissoa variabilis (von Mühlfeld)	5·6 – 7·1			+		+		+	
Alvania lineata Risso	4·1 – 4·6			+		+			
Cerithium vulgatum Brugière	3·2 – 44·5			+	++	+	+	+	+
C. rupestre Risso	14·2 – 19·8				+				
Bittium reticulatum (da Costa)	3·0 – 10·4			+	+	+			
Murex trunculus (Linnaeus)	4·0 – 42·5			+		+	+		
Tritonalia edwardsi (Payraudeau)	7·1 – 16·3	+		+	+				
Muricopsis blainvillei (Payraudeau)	4·4 – 17·0	+					++	+	
Columbella rustica (Linnaeus)	5·0 – 17·8			+	+++	+++	+++	++	+
C. scripta (Linnaeus)	11·9 – 12·2						+		
Pisania maculosa (Gmelin)	3·5 – 23·9			+	+++	++	+	++	
P. d'orbignyi (Payraudeau)	15·6			+					
Nassarius costulatus (Weinkauff)	8·6 – 8·7			+					
Fasciolaria lignaria (Linnaeus)	34·1 – 41·4						+		+
Fusus syracusanus (Linnaeus)	30·5 – 31·8								+
Mitra ebenus Lamark	8·2 – 9·0			+		+		+	
M. cornicula Lamark	12·7						+		
Pusia littoralis (Forbes)	5·8 – 5·9						+		
Conus mediterraneus Hwass	4·7 – 31·2			+	++	+	++	+	
Aplysia fasciata Poiret	6·5 – 18·8			+	+	+			
A. punctata Cuvier	15·5					+			

+ = rare ++ = common +++ = abundant

of low cliffs giving way to pebbles in the infralittoral zone. Moderate amount of algae in the upper zones with abundant gastropods.

9. Lindos point, fairly exposed point between 7 and 8; rocky with good growth of red and brown algae. Gastropods common.
10. Lindos Bay, sheltered area inside breakwater, sandy beach with pebbles covered mostly by green algae in the higher zones. Gastropods abundant.

RESULTS

Thirty species were found, twenty-three from Tinos and twenty-three from Rhodes. Sixteen were common to both islands and most of these common ones were widespread. The species are listed in the table together with the size range of each and their relative abundance in the different zones.

DISCUSSION

Littorina neritoides occurred in the splash zone of rocky localities except at Rhodes town which was poor in other species: presumably due to the effluent from the slaughter house. On the exposed point between Lindos Bay and St. Paul's Bay the molluscs were more numerous although the substrates were the same: this confirms the importance of spray for this species.

Patella caerulea was found mainly on bare rock often just below the water line. Specimens from Tinos were usually larger than those from Rhodes. *Monodonta turbinata* was also usually found on bare rock in the upper intertidal zone.

Gibbula adansoni, Columbella rustica, Pisania maculosa and *Conus mediterraneus* were all common where algal growth was rich, although they occasionally were found on bare rock. *G. adansoni* was found at rather deeper levels than the others. *C. mediterraneus* was rare on green algae which were confined to pebbles. No specimens more than 20mm long were found on Tinos. *Gibbula richardi* and *Bittium reticulatum* were found only on green algae and therefore were not common.

FRESHWATER GASTROPODS

During the summer months there is not very much freshwater available since most stream beds are dry, but occasional pools remain. Most water is piped at source but some spring water is fed into donkey troughs; these are common on Tinos. On Rhodes, water from artesian wells is piped into larger open tanks then led off for irrigation, so the land looks much greener.

The Localities sampled

TINOS ISLAND, (TFW)

3, 5 & 13. St Parasiei, Zabaroimich and Baueta, north of Tinos town. 6. Kolimbetra Bay. 7. Loutra. 10 & 12. Koumaros. 11. Krois, Loutra. 14. Panormos Bay. 15. Pyrgos.

RHODES ISLAND, (RFW)
11. Maloni. 16. Petaloudes.

RESULTS

Seven species were found: six were confined to Tinos, and the remaining species had a different subspecies on each island.

SPECIES FOUND
Hydrobia ventrosa (Montagu)
Potamopyrgus jenkinsi (Smith)
Limnaea truncatula (Müller)
Melanopsis praemorsa buccinoidea (Olivier)
M. p. mingrelica (Mousson)
Planorbis planorbis (Linnaeus)
Ancylus fluviatilis Müller

DISCUSSION

On Tinos most isolated pieces of water contained snails. *Potamopyrgus jenkinsi* was particularly widespread, occurring in seven out of ten possible sites. It was found in donkey troughs, village washing places, pools in river beds and the brackish water at Kolimbetra, but not at Panormos. The brackish lagoon at Panormos was the only site where we found *Hydrobia ventrosa*. *Planorbis planorbis* was found at three places (two donkey troughs at Tinos and a river bed at Krois) and *Limnaea truncatula* at two (donkey trough and cement washing place at Koumaros), both usually with *P. jenkinsi,* but never together. There was nothing obvious to account for the differences. *Melanopsis praemorsa mingrelica* occurred in the stream running through Loutra which was used as the village laundry.

Rhodes had less open running water than Tinos. We found no snails in the storage tanks of artesian wells, nor in donkey troughs nor in an artificial lake at Rhodini, south east of Rhodes town. *Melanopsis praemorsa buccinoidea* was found in an open cement irrigation channel at Maloni and in one tributary of the stream at Petaloudes. At both these sites it was very abundant. The finding of only one species on Rhodes was unexpected. The island is larger than Tinos and closer to the mainland.

TERRESTRIAL GASTROPODS

Because there is little rain in the summer months the land becomes parched except where there are natural streams or where the land is artificially irrigated. Even in watered places the gastropods had to aestivate attached to walls, rocks or vegetation or buried in litter. They usually occurred in groups or close together. We found *Limax flavus* at night by a storage tank in a Rhodes garden.

The Localities sampled

TINOS ISLAND, (TT)

3 & 5. St. Parasiei and Zabaroimich, north of Tinos town. 6 Kolimbetra.
7, 9 & 8. Loutra, Koumaros and in between the two. 16. Pyrgos.

RHODES ISLAND, (RT)

4, 13 & 15. Rhodes town. 3. Kritica. 12. Trianda. 6. Lindos. 11. Maloni.

RESULTS

Eighteen species were identified; eleven from Tinos (T) and sixteen from Rhodes (R), of which nine were common to both islands.

SPECIES FOUND	DISTRIBUTION	
Zebrina detrita (Müller)		R
Mastus pupa (Férussac)	T	
Rumina decollata (Linnaeus)		R
Vitrea inopinata Uličny		R
Limax flavus Linnaeus		R
Albinaria brevicollis (Pfeiffer)	T	R
A. olivieri (Roth)	T	R
Cernuella candiota (Mousson)	T	
C. virgata (da Costa)	T	R
C. species	T	R
Helicella obvia (*Hartman*)	T	R
Cochlicella ventricosa (Draparnaud)	T	R
Monacha syriaca (Ehrenberg)	T	R
Metafruticicola pellita (Férussac)	T	R
Theba pisana (Müller)		R
Eobania vermiculata (Müller)	T	R
Helix aspersa Müller		R
H. figulina Parreysse		R

DISCUSSION

Dry stone walls were favourite sites for aestivating snails, which hid in gaps between stones. *Eobania vermiculata* was common in colonies here. The five-banded shells showed eight band patterns, but since the animals were aestivating we cannot correlate the patterns with habitat. Two species of *Cernuella* were also quite common here.

Albinaria was usually found attached to mortared walls, but also on others and on trees and in the litter below. It was common in towns and villages. *A. brevicollis* was widespread on Tinos but was found only at Lindos on Rhodes. *A. olivieri* was found in gardens in northern Rhodes and at Pyrgos on Tinos.

The trunks of trees, especially the rough-barked ones, e.g. cypress, form another common habitat. *Cochlicella ventricosa* was found in gardens and churchyards

near both Tinos and Rhodes towns. *Helix aspersa, Zebrina detrita* and *Albinaria* spp. also occurred on trees.

Z. detrita was abundant on Monte Smith in Rhodes town and in a field at Maloni. It was mostly attached to tall dry grasses; and these were two of the few sites where these were common. It showed white and brown-and-white morphs.

Rumina decollata was very common in a pine wood at Lindos, but was found on only one other occasion. It was mostly found buried in groups in litter at the base of trees, but also attached to rocks.

Other species showed little habitat preferences.

The finding of six more species on Rhodes than on Tinos is in keeping with its larger size and closer proximity to the mainland.

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NOTES ON THE OCCURRENCE OF *VERTIGO ANGUSTIOR* JEFFREYS IN GREAT BRITAIN

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(*Read before the Society, 17 March 1973*)

INTRODUCTION

In the past, papers have been published in the Journal of Conchology on most of the rarer British species of *Vertigo: V. alpestris* Alder and *V. pusilla* Müller (Dean and Kendall, 1908); *V. moulinsiana* (Dupuy) (Tomlin and Bowell, 1908); *V. lilljeborgi* Westerlund (Kevan and Waterston, 1933); and *V. geyeri* Lindholm (Norris and Pickrell, 1972). Little information however has ever been published on *V. angustior* Jeffreys, either on its recent distribution or its habitat preferences. This paper is an attempt to remedy this deficiency and record information gathered by ourselves whilst studying this genus.

On 11 June 1972, whilst examining fens and common land in East Anglia in search of *Vertigo angustior*, we visited an area of land known as Flordon Common (NGR TM (62) 182973). The abundance of this species in limited areas of the common soon became evident, a small sample of herbage removed subsequently producing several hundred living specimens. In England live *V. angustior* have always been scarce, most of the records being of fossil or dead shells; in Ireland the situation is better with a number of stations known. The scarcity of sites from which live material has been recorded makes it important to take into account all available facts when assessing the occurrence of *V. angustior*. In this paper we have attempted to gather these facts together to form a comprehensive picture of its history, distribution and habitat preferences. This has involved reviewing the status of some old records. The only sites we list are those from which living animals have been recorded, or available evidence suggests that *V. angustior* probably occurs at or near the place of recording.

DESCRIPTION

Jeffreys original description was based on specimens from rejectamenta of a small stream at Marino near Swansea (Jeffreys, 1833a: 361). The known distribution suggests that these specimens were not of recent origin. Jeffreys' original specimens are no longer identifiable and hence the species is based on the following description :—

Testa ventricosior, subdolioliformis, pallidè fulva, argutè et lentissimè striata. *Anfractus* 4–5, penultimâ vix latiori. *Apertura* subtriangularis, dentibus 4–5, nempé 2 columellaribus et 2–3 labralibus insignita: *peristomio* subincrassato. *Umbilicus* angustatus. Long. 0·06—Diam. 0·035 [lines].

The following description is our own, a fuller account can be found in (Jeffreys, 1862:265), or (Ellis, 1926:150). *The Shell*—Sinistral; between spindle and barrel shaped (subfusiform); fairly strong; semi-transparent; glossy with strong oblique striations; *Colour*—light horn (occasionally darker); *Mouth*—narrow, nearly triangular; *Teeth*—4–5, 2 parietal, 1 columellar and 1 or 2 palatal. The outer parietal and the columella teeth are the most strongly developed and nearest the aperture. The columella tooth takes the form of a strong curved plate; *Whorls*—4½; *Umbilicus*—indistinct.

Size—Height 1·5–2 mm.; Breadth 0·75–1 mm.

The Animal—Short stumpy; blackish in front, greyish on sides and underneath with a yellowish-grey mantle. *Tentacles*—thick, dusky grey and somewhat cylindrical; *Foot*—pale grey. The animal characteristically carries its shell at right angles to its body. Compared with *V. pusilla,* the only other sinistral British vertiginid, *V. angustior* is slightly smaller, narrower, more solid and has stronger striations. The number of apertural teeth is also smaller.

LIST OF LOCALITIES

Many of the vice-comital records (Ellis, 1951) are based on specimens of fossil or of doubtful origin and have not been included. The localities are listed in vice-county order, then by grid reference.

V.C.17. *Surrey*

BATTERSEA FIELDS TQ(51)2777

A single specimen is recorded (Jeffreys, 1833b, p. 517) as follows: "Mr. Stephens also possesses a young specimen from Battersea Fields". No information is available on the original habitat and the present state of the area makes its extinction certain. The marshes were destroyed in the 1850's by the dumping of material excavated from the London Docks.

V.C.25. *East Suffolk*

REDGRAVE FEN TM(62)0479

One specimen is recorded from rejectamenta (Taylor & Roebuck MS) collected by A. Mayfield, and reported in "The Non-Marine Mollusca of Suffolk" (Mayfield, 1909b). The area in which the specimen was located is typical fen, a mixture of reed, tall grasses, rushes and sedges, and is now incorporated in the property managed by the Suffolk County Trust. No trace of *V. angustior* could be found in 1972.

ALDEBURGH TM(62)45

Four specimens were found in 1903 by J. E. Cooper and exhibited before the

Society to illustrate a paper "Some Mollusca, from Aldeburgh, Suffolk" and were subsequently presented to the Society's voucher collection (*J. Conch. Lond.* 8 : 171) and are now in the British Museum, Natural History. The paper was never published in the Journal and we have been unable to trace any reference to its publication elsewhere. Aldeburgh as a locality is vague, a possible habitat was destroyed during the construction of the local golf links.

V.C.27. *East Norfolk*
ROYDON FEN TM(62)07

On 11 July 1908, A. Mayfield collected more than 100 specimens of *V. angustior* from a small sample of rejectamenta. The material also yielded numbers of *V. pygmaea* (Drap.), *V. antivertigo* (Drap.), and ten *V. moulinsiana* (Mayfield, 1909a). Intensive cultivation of the surrounding farmland has encroached, diminishing the area of the fen, and in 1972 we found it to be badly overgrown with willows and alder. An intensive search failed to reveal *V. angustior*.

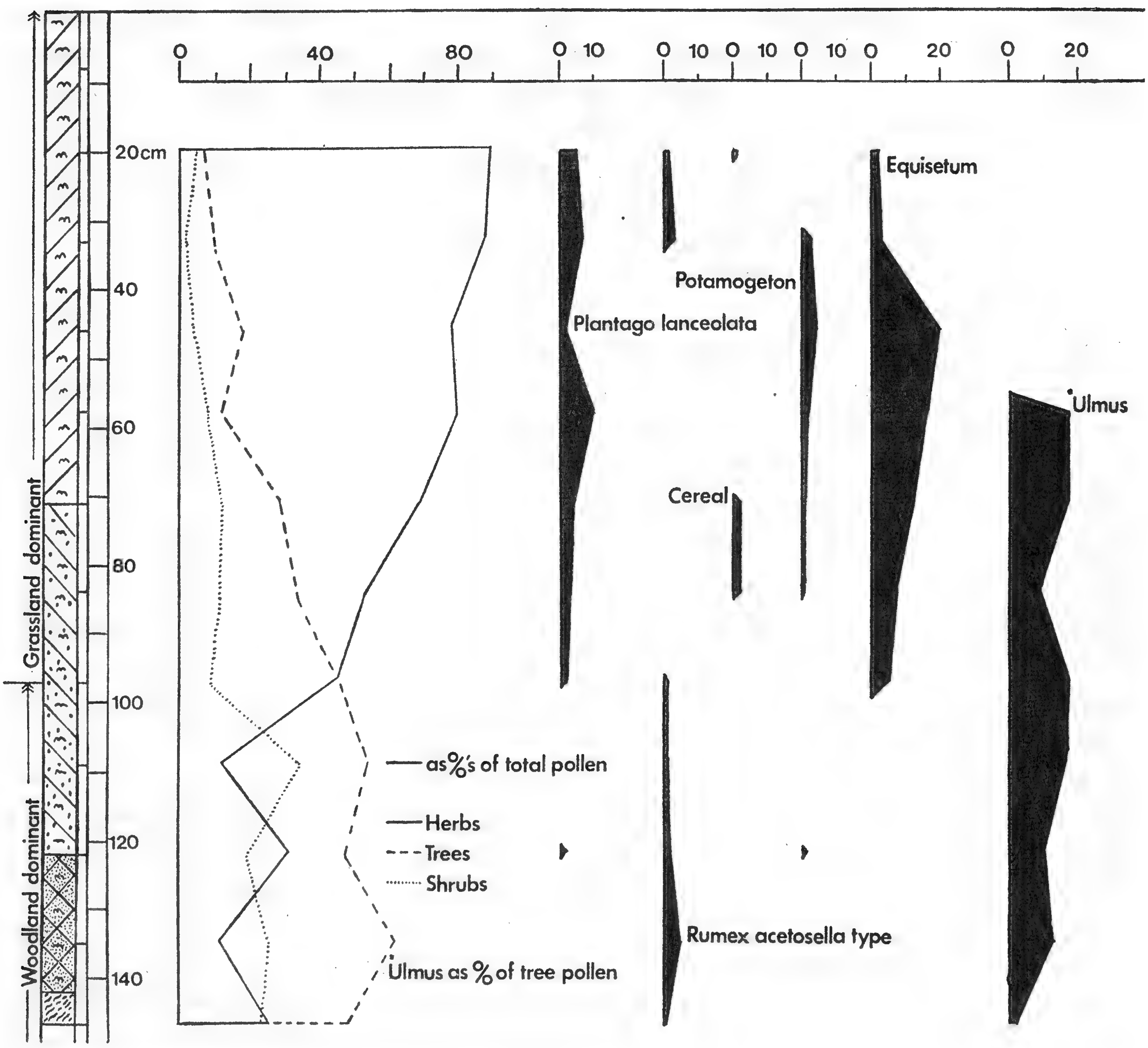
FLORDON COMMON TM(62)182973

A. Mayfield identified a number of *V. angustior* amongst other Mollusca taken from a small quantity of marsh soil sent to him from a mole-hill (Burrell and Clarke, 1910). In April 1947, A. E. Ellis found fresh shells in flood debris whilst examining the area for the vice-comital census. The first living examples were collected by ourselves on 11 June 1972.

Flordon Common is situated to the west of the village of Flordon and about 7½ miles south by west of Norwich. The common is in two main parts, the road from Flordon to Hapton cutting across a little west of centre. The area to the west of this road is mainly at a higher level and now lacks any substantial area of marsh. To the east is a large area of marshy meadow which slopes slightly from north to south. It was in this area that we found *V. angustior* in abundance. Situated in the base of a wide shallow valley with a small brook, a tributary of the River Tas, forming its southern boundary, the common has long been noted as a place of botanical interest and is designated as a Site of Special Scientific Interest, (S.S.S.I.). The Upper Chalk forms the floor of the valley overlaid by a series of ferruginous gravels and sands of the Norwich Crag series. Above this lies a series of sands, gravels and calcareous, silty, loamy boulder clays of glacial origin. The recent valley deposits which form the main area of the common were sampled to a depth of 147 cm. showing the following succession; surface to 71 cm. organic clay-mud of a burnt umber colour; 71 to 122 cm. a dark brown organic clay-loam; a sandy organic clay-loam then occurred down to 142 cm., a whitish marly deposit was just penetrated at this level. The high water content at the lower levels made sampling difficult and was adjourned at 147 cm. before base was reached.

A pollen analysis was carried out by Dr. D. D. Bartley to try and establish the probable relationship between *V. angustior* and its habitat at various levels in the deposit. Figure 1 shows a simplified pollen diagram of the general herb, tree and shrub flora with individual graphs of *Plantago lanceolata, Rumex aceto-*

sella, cereal, *Potamogeton*, *Equisetum* and *Ulmus*. From the graphs of tree and herb pollens it can be seen that the area has gradually changed from a landscape that was predominantly forest to meadowland. The occurrence of *Potamogeton* and the increase of *Equisetum* pollen from 33 to 58 cm. shows that the area must have become very wet during this period. The occurrence and frequency of *Vertigo* species in the deposit corresponds with the decrease of the forest; falling off with the increase of wet conditions and increasing as the area dried out.

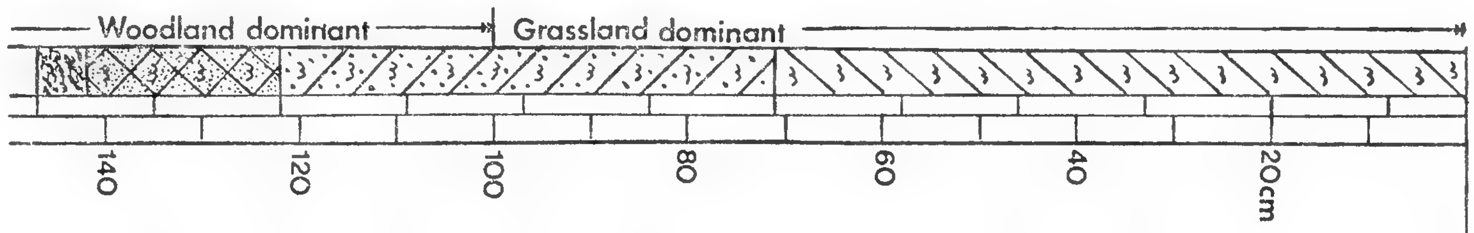


Simplified pollen diagram from Flordon Common, East Anglia. fig. 1.

The abrupt fall in values of *Ulmus* pollen at 58 cm. cannot be regarded as the classical "elm decline" because below this level there are quite high values of such pollen types as *P. lanceolata R. acetosella* type, cereal and *Centaurea cyanus,* all of which usually appear after the elm decline.

At the base of the diagram elm values are very low suggesting that this might possibly be immediately post "elm-decline" and the recovery of elm to fairly high values might reflect the recovery of elm in the calcareous soils.

FREQUENCIES OF POLLEN TYPES FROM FLORDON COMMON, EAST ANGLIA.



Betula	3	2	2	3	2	2	1	-	4	3	-
Pinus	1	2	1	-	1	2	-	-	-	-	2
Ulmus	1	8	5	9	8	3	5	2	-	-	-
Quercus	32	34	27	29	20	15	14	6	4	3	2
Tilia	6	9	8	9	6	4	3	4	4	-	-
Alnus	3	5	4	5	6	6	5	-	6	4	2
Fraxinus	3	2	1	-	3	2	1	-	-	-	-
Corylus	23	26	19	32	8	10	12	6	4	2	2
Salix	2	-	-	1	-	1	-	2	-	-	2
Hedera	-	-	1	-	1	1	-	-	-	-	-
Gramineae	7	5	12	8	12	22	25	28	26	32	28
Cyperaceae	9	1	8	-	19	13	15	14	36	22	30
Matricaria	-	-	1	-	-	2	-	-	-	-	3
Senecio type	1	-	3	1	2	-	-	6	2	1	1
Cirsium Type	-	-	-	-	-	-	3	-	-	-	-
Taraxacum type	-	-	-	-	2	2	1	6	-	5	8
Umbelliferae	-	-	1	-	-	-	-	2	-	2	2
Plantago lanceolata	-	-	2	-	2	3	4	10	2	7	5
Trifolium	-	-	-	-	-	-	-	-	-	1	1
Rosa type	-	-	-	-	-	-	-	-	-	-	1
Rumex acetosella	1	5	2	1	1	-	-	-	-	3	1
Ranunculus	3	-	-	1	2	3	4	4	2	8	5
Caryophyllaceae	-	-	-	-	1	1	-	-	-	-	1
Cereal	-	-	-	-	-	2	2	-	-	-	1
Potentilla	-	-	-	-	-	-	-	-	-	-	3
Cruciferae	1	-	1	-	3	3	1	8	-	5	-
Lotus	-	-	1	-	-	-	1	-	2	1	-
Caltha	-	-	-	-	-	-	-	-	8	-	-
Chenopodiaceae	1	-	-	-	-	-	1	-	-	-	-
Plantago major/media		-	-	-	-	-	1	-	-	-	-
Centaurea cyanus	-	-	-	-	-	1	-	-	-	-	-
Filipendula	-	-	1	-	-	-	-	-	-	-	-
Unknown	3	1	-	1	1	2	1	2	-	1	-
Potamogeton	-	-	1	-	-	1	1	2	4	3	-
Menyanthes	-	-	-	-	-	-	-	2	-	-	-
Nuphar	1	-	-	-	-	-	-	-	-	-	-
Equisetum	-	-	-	-	5	7	12	16	20	3	2
Pteridium	-	-	-	-	-	-	-	2	2	1	3
Polypodium	-	1	-	-	1	-	-	-	-	-	-
Filicales	6	-	3	-	4	7	6	16	4	4	-
Sphagnum	-	-	-	-	-	1	-	-	-	-	1

(Values expressed as percentages of total pollen).

Table 1.

What seems fairly certain is that these valley deposits have been laid down since about 3000 B.C.

V. angustior occurs in the top 33 cm. of the deposit, but it must be remembered

that this is within range of possible surface contamination. The occurrence of a single specimen at 71 cm. may be due to contamination, rejectamenta deposited at this spot from another part of the common, or it may have originated from a different locality. (It is known from a number of deposits in south-east England (Sparks, 1964)). It cannot be assumed that the absence of this species at the lower levels indicates it is a recent addition to the fauna of the common, only that conditions near the sample were unsuitable.

On the surface, living specimens can be found in abundance at the roots of grasses and other plants, rarely climbing higher than 8 cm. above the soil surface.

FREQUENCIES OF MOLLUSCAN TYPES FROM FLORDON COMMON, EAST ANGLIA.

Woodland dominant — Grassland dominant

140 120 100 80 60 40 20cm

													A. M. 1909.	Killanley
Valvata cristata Muller	C	A	A	A	A	A	A	C	2	1	1	-	X	-
Bithynia tentaculata (L.)	1	S	S	S	S	S	C	S	S	-	-	-	-	-
Carychium minimum Muller	-	2	3	-	1	-	4	-	2	-	7	X	-	X
C. tridentatum (Risso)	-	3	2	1	3	2	-	-	3	5	C	X	-	-
Lymnaea truncatula (Muller)	S	A	S	A	C	S	C	S	-	S	4	-	X	-
L. peregra (Muller)	S	C	S	A	C	C	C	S	S	-	-	-	X	-
Planorbis carinatus Muller	-	-	-	-	-	2	1	1	-	-	-	-	-	-
P. vortex (L.)	-	-	-	-	-	-	-	-	-	-	-	-	X	-
P. albus Muller	-	-	-	-	3	-	-	-	1	1	-	-	-	-
P. crista (L.)	-	-	A	S	C	S	C	-	-	2	-	-	-	-
P. contortus (L.)	-	-	-	-	-	-	-	1	-	-	-	-	-	-
Succinea sp.	1	S	-	-	S	S	S	S	-	S	2	-	X	-
Cochlicopa lubrica (Muller)	-	-	-	-	1	-	-	1	1	2	8	X	X	X
C. lubricella Porro	-	-	-	-	-	-	-	-	-	1	-	-	-	-
Columella edentula (Drap.)	-	-	-	-	-	1	-	-	-	-	2	X	-	X
Vertigo antivertigo (Drap.)	-	1	-	2	4	4	1	1	2	11	9	X	-	X
V. substriata (Jeff.)	-	-	1	-	-	2	-	-	-	1	2	X	-	X
V. pygmaea (Drap.)	-	-	-	-	-	-	-	-	-	6	17	X	X	X
V. angustior Jeff.	-	-	-	-	-	-	1	-	-	3	8	A	X	X
Lauria anglica (Wood)	-	-	-	-	-	-	-	-	-	-	-	-	-	X
Acanthinula aculeata (Muller)	-	-	-	-	-	-	-	-	-	-	-	X	-	-
Vallonia costata (Muller)	-	-	-	-	-	-	-	-	-	-	-	X	-	-
V. pulchella (Muller)	-	-	1	-	3	-	-	-	-	8	15	-	X	-
V. excentrica Sterki	-	-	-	-	-	-	-	-	-	-	2	-	-	-
Clausilia bidentata (Strom)	-	-	-	-	-	-	-	-	-	-	-	X	-	X
Helix nemoralis (L.)	-	-	-	-	-	-	-	-	-	-	1	X	X	-
Hygromia hispida (L.)	-	-	-	-	1	2	1	-	2	2	6	X	X	X
Monacha granulata (Alder)	-	-	-	-	-	-	-	-	-	-	-	-	-	X
Punctum pygmaeum (Drap.)	-	-	-	-	-	-	-	-	-	-	3	X	X	X
Arion intermedius Normand	-	-	-	-	-	-	-	-	-	-	-	X	-	X
A. circumscriptus Johnston	-	-	-	-	-	-	-	-	-	-	-	-	-	X
A. c. silvaticus Lohmander	-	-	-	-	-	-	-	-	-	-	-	-	-	X
A. subfuscus (Drap.)	-	-	-	-	-	-	-	-	-	-	-	-	-	X
A. ater agg.	-	-	-	-	-	-	-	-	-	-	-	-	-	X
Euconulus fulvus (Muller)	-	-	-	-	-	-	-	1	-	2	-	X	-	X
Vitrea crystallina (Muller)	1	-	1	-	-	-	-	-	-	-	10	X	-	X
V. contracta (West)	-	-	-	-	-	-	-	-	-	-	-	X	-	-
Retinella radiatula (Alder)	-	-	-	-	1	-	1	-	3	4	5	X	-	-
R. pura (Alder)	-	-	-	-	-	-	-	-	-	-	-	-	-	X
R. nitidula (Drap.)	-	-	-	-	-	-	-	-	-	-	1	X	-	X
Agriolimax reticulatus Muller	-	-	-	-	-	-	-	-	-	-	-	-	-	X
A. laevis (Muller)	-	-	-	-	-	-	-	-	-	-	-	X	-	X
A. sp.	-	-	-	2	-	-	-	-	-	-	3	-	-	-
Sphaerium corneum (L.)	-	-	-	-	1	-	-	-	-	-	-	-	-	-
Pisidium amnicum (Muller)	-	-	-	-	1	-	-	1	-	-	-	-	-	-
P. casertanum (Poli)	-	-	1	2	2	8	2	2	4	C	9	X	-	-
P. personatum Malm	-	-	-	-	-	-	-	-	1	5	4	X	-	-
P. milium Held	-	10	7	C	8	C	C	4	2	9	4	-	-	-
P. subtruncatum Malm	-	1	4	-	2	9	8	2	2	6	1	-	-	-
P. hibernicum West.	-	-	2	-	-	1	-	-	-	-	-	-	-	-
P. nitidum Jenyns	2	5	C	C	C	C	C	C	3	4	3	X	-	-

A = Abundant
C = Common 50+
S = Scarce 20-50
X = Living or recent.

Table 2.

A sample of plants was taken from an area where *V. angustior* proved particularly common and were identified as follows:—*Mentha aquatica* L.; *Hydrocotyle vulgaris* L.; *Lotus uliginosus* Schkuhr; *Equisetum palustre* L.; *Ranunculus acris* L.; *Cerastium holosteoides* Fries; *Plantago lanceolata* L.; *Prunella vulgaris* L.; and *Trifolium pratense* L., all species classed as widespread and common on marshy meadows, grassland and waste places generally. A fairly comprehensive list of the flora of the common can be found in Burrell and Clarke, 1910.

SMOTTON COMMON TM(62)2198

A. E. Ellis collected a number of fresh shells from flood rejectamenta in April 1947. However, the occurrence of *V. angustior* on this common, although not improbable, can be called into question. A number of small brooks criss-cross the area bordering the River Tas at Saxlingham Thorpe making it possible for these specimens to have originated from a number of sources, and not impossible for them to have been washed down the Tas from Flordon Common. A search of suitable habitats on the common in 1972 failed to produce further examples.

V.C. H.1. *South Kerry*

FERRITER'S COVE, DINGLE IGR Q(01)30

Ferriter's Cove is situated to the north of Clogher Head at the most south-westerly point of the Dingle Peninsula. A. W. Stelfox recorded three living specimens on 17 September 1914, from under stones, on dunes (Stelfox, 1915). As far as we can ascertain, no attempts have been made to find *V. angustior* since this date.

CLOGHANE, DINGLE Q(01)51

In May 1909, J. R. le Brockton Tomlin recorded *V. angustior* as being not uncommon in one spot, on the banks of a small stream close to where it entered the sea, near Cloghane (Taylor and Roebuck MS). A. W. Stelfox found a single living specimen under a stone in the dunes opposite Fermoyle House, Cloghane in 1914 (Stelfox, 1915).

This site was visited by G. Visser and J. A. Zoer in July 1971 and *V. angustior* was found to be fairly common in what they describe as medium wet meadows, extensively grazed by cattle, directly behind the sand-dunes near Fermoyle House (Visser and Zoer personal communication). The herb flora of the area was examined and the following species recorded:—*Iris pseudacorus* L.; *Ranunculus acris* L.; *R. repens* L.; *Trifolium repens* L.; *T. pratense* L.; *Senecio jacobaea* L.; *Potentilla anserina* L.; *Cerastium arvense* L.; *Plantago lanceolata* L.; *Centaurea nigra* L.; *Cirsium arvense* (L.); *Leontodon autumnalis* L.; *Rumex crispus* L.; *Eleocharis uniglumis* (Link); *Holcus lanatus* L.; *Poa trivialis* L.; *Festuca rubra* L.; *Cynosurus cristatus* L.; and *Agrostis stolonifera* L. All the above species with the exception of *Eleocharis* are widespread and common in grassy places. The specimens of *V. angustior* were found, under stones, in association with *V. pygmaea*; *Cochlicopa lubrica* (Müller); *Vallonia pulchella* (Müller) and *Agriolimax reticulatus* (Müller), occasional specimens of *Helix nemoralis* L. and *H. aspersa*

Müller also occurred. G. Visser and J. A. Zoer considered this area to be unstable and in a state of transition between the extremes of dry/wet, salt/fresh and eutrophic/oligotrophic, a situation which is often characterised by the poor molluscan fauna.

DERRYNANE Q(01)55

A small series of live specimens taken from this locality by H. E. Quick in 1949 are housed at the British Museum, Natural History. This record has never been published and no details are known.

V.C. H.3. *West Cork*

GOLEEN V(00)82

Examples of *V. angustior* collected by W. E. R. Hackett in April 1939 were accepted as living, in the records of the Conchological Society's Census (Ellis, 1951).

V.C. H.9. Clare

MILLTOWN MALBAY Q(11)07

Brown (1845, p. 52) recorded this species as having been found at this locality by W. H. Harvey.

R. A. Phillips located specimens on the west coast in Co. Clare between Milltown Malbay and Spanish Point on 21 April 1909 (Phillips MS). No further details are known.

LEHINCH Q(11)08

P. H. Grierson recorded *V. angustior* as occurring in wet moss on the sand-dunes at Lehinch in association with *V. substriata* (Jeffreys) in 1900 (Grierson, 1902). In March 1918, R. A. Phillips also located living specimens in the same situation.

V.C. H.13 *Carlow*

BORRIS BRIDGE S(21)75

P. H. Grierson took a number of live specimens from wet spongy moss on the south side, near to the River Barrow, and close to the bridge over the Barrow, known as Borris Bridge, circa 1900 (Grierson, 1903, 1904).

V.C. H.16. *West Galway*

DOGS BAY L(02)63

V. angustior has been recorded over many years from the area around Dogs Bay and in this account we have mentioned only a few significant records.

A. W. Stelfox recorded it in 1906 from two different types of habitat in the Dogs Bay area. The first he described as a wet field with a rich mixture of herbage by the side of the track leading down from the road to the bay (personal communication). *V. angustior* could be found under stones here in large numbers. A recent visit to this site by J. F. Peake proved the species to be just as common

now as it was in 1906. The second type of habitat was under stones, lying on moss, in damp hollows between Earawalla Point and Gorteen Bay, in this habitat one of us (AN) recorded two specimens in August 1970.

V.C. H.19 *Kildare*
DIGBY BRIDGE N(22)8624

Digby Bridge is one of the bridges over the Grand Canal near Sallins. Six live specimens were located by C. R. C. Paul and one of us (AN), in the roots of plants in damp, sedgy grassland heavily trampled by cattle on 1 April 1971. The field is at a lower level than the canal, and may be prone to flooding in very wet weather. Mollusc associates include *Columella edentula, Vertigo pygmaea, V. substriata, V. moulinsiana* and *V. antivertigo*, but a full list was not kept.

LEIXLIP N(22)9936

D. K. Kevan located two living specimens on 16 April 1932, and a further three on 1 January 1933, in the marshes on the west side of the Rye Water by the aqueduct near Leixlip (Kevan, 1933). The molluscan associates were *Vertigo antivertigo*; *Columella edentula* (Drap); *Carychium minimum* agg.; *Punctum pygmaeum* (Drap); *Succinea putris* (L.); *Agriolimax leavis* (Muller); *Arion ater* agg.; and *Lymnaea truncatula* (Müller). The flora noted in January 1933 is limited, due to the time of the year, and is as follows:—*Iris pseudacorus* L.; *Equisetum fluviatile* L.; *Epilobium hirsutum* L.; *Mentha aquatica* L.; *Phalaris arundinacea* L.; *Juncus inflexus* L.; with *Sparganium ramosus* Huds.; and *Carex* species, the last two are reported as being dominant. He states that *V. angustior* was found on the decaying leaves of *Sparganium*.

On 11 April 1968, D. C. Long and AN located a single living specimen from amongst the roots of *Iris pseudacorus* L., growing on the banks of the Royal Canal near Leixlip.

V.C. H.27 *West Mayo*
DOOAGHTRY LOUGH L(02)7469

Dooaghtry Lough is one of three shallow lakes which occur on a rough uncultivated area known as Dooaghtry. On 15 September 1909, A. W. Stelfox located a thriving colony living on the sides of stones sunk in more or less wet ground, and particularly common in clumps of the moss *Brachythecium velutinum* (Hedw.) (= *Hypnum velutinum* L.) which grows on and around the stones, (Stelfox, 1912). A list of associated Mollusca was not given, only a general list for the area.

V.C. H.28 *Sligo*
*KILLANLEY GLEBE** G(13)264248

Miss Amy Warren recorded *V. angustior* as being very common at the roots of grass in a small spot in Killanley Marsh near the village of Killanley in 1879

* Glebe – Land belonging to the Church

(Warren, 1879, 1892). Miss Warren could only find them on favourable days when the atmosphere was warm and moist. One of us (AN) visited this site on 4 August 1972 in company with other members of the Conchological Society whilst on a field trip to the area. *V. angustior* proved to be still very common in the roots of mixed herbage in several areas of the marsh. A sample of the herbage was removed and identified as follows:—*Juncus acutiflorus* Hoffman; *Carex disticha* Hudson; *Eleocharis palustris* (L.); *Holcus lanatus* L.; *Lathyrus pratensis* L.; and *Dactylorchis praetermissa* (Druce). A full list of molluscan associates is included as an appendix to table 2.

V.C. H.39 *Antrim*
GIANTS CAUSEWAY C(24)9444

J. N. Milne found a single living specimen in 1909, in a sheltered bay between Port Noffer and Port Moon. A. W. Stelfox (personal communication) stated that although he and a number of other collectors had examined this area over a number of years, this was the only living specimen ever found, all the other records being of dead shells.

4. ADDITIONAL LOCALITIES

The following five localities were accepted as living vice-comital records in the Conchological Society's Census (Ellis, 1951). We feel that there is insufficient evidence to justify this and these records should not be accepted until they can be reconfirmed.

V.C. 30 *Bedfordshire*
Nr. DYER'S HALL FARM TL(52)045292

The farm is situated near the village of Upper Sundon from which B. Verdcourt recorded a dead shell in 1947 (Verdcourt, 1949). This record is almost certainly based on a fossil specimen.

V.C. 54. *North Lincolnshire*
NORTH SOMERCOTES TF(53)49

Three specimens were located at the roots of grass, growing on a sandbank in the warren at North Somercotes in July 1900, by C. S. Carter (Taylor and Roebuck MS). These specimens are probably also fossil.

V.C. 63 *South-west Yorkshire*
WENT VALE SE(44)41

Charles Ashford reported finding a single specimen amongst numerous *V. pusilla* collected from the north side of Went Vale in 1854 (Ashford, 1888). The specimen was located many years after the date of collection and could have been due to contamination whilst in his cabinet; this type of contamination is commonplace and can happen no matter how careful the collector is.

V.C. 107. *East Sutherland*
STRATHBRORA(?) NC(29)80(?)

W. Baillie reported finding a single specimen in 1881 somewhere in East Sutherland "Amongst a lot of *pupa* collected in 1881 in E. Sutherland and kept in tin boxes all winter, I found one *Vertigo angustior*", (Baillie, 1882). This specimen may have even been in one of these boxes before the collecting trips in 1881 and therefore could have originated from almost anywhere.

H.11. *Kilkenny*
GRAIGUENAMANAGH S(21)74

R. A. Phillips reported finding nine dead shells in river debris on the banks of the River Barrow two miles below Graiguenamanagh on 9 April 1933. The Barrow is a large river, and rejectamenta deposited on its banks could have travelled many miles downstream. The specimens may have been of recent origin, but this locality cannot be accepted as their place of abode.

GEOLOGICAL HISTORY

V. angustior is a common fossil in many inter-glacial and post-glacial deposits all over lowland Britain. In Ireland it is particularly common on the sand-dunes of the north-west coast. This species had a wider geographical distribution in the Boreal and Atlantic periods of the post-glacial than at the present day. The present restricted distribution was probably brought about by man draining its habitats and generally drying out the landscape for use as farm and grazing land (Kerney, 1968). Those habitats situated on sand-dunes may have been affected in this way, by the general decrease in atmospheric humidity due to climatic changes, or by in filling, in what must have been restricted and localized conditions.

HABITATS

The habitats of *V. angustior* in Britain can be divided into two different specific categories. The first of these, normally situated on sand-dunes or low lying exposed areas are generally described as mossy hollows or, more or less, wet ground covered in moss. At Dooaghtry Lough, Stelfox reports *V. angustior* as being particularly common in clumps of the moss *Brachythecium velutinum* which grows on and around the stones (Stelfox, 1912), this being the only site from which a moss has been specifically named; the species of moss may be important but this is unlikely. The conditions which allow mosses to grow on a loose substrate like sand would be more important. The second habitat type can best be described as rich marshy meadows, a mixture of both marsh and typical damp meadow vegetation, the essential point being that the area must not have been ploughed or turned over to any extent in the past.

V. angustior needs conditions which are stable, and yet in a state of slow transition, being in the main limited to areas in which the marsh habitat has gone but the next stage in the transition, meadowland, has not yet become fully established. Those specimens recorded from fens were probably deposited in that

situation from marshy meadows nearby. *V. angustior,* like most species of *Vertigo,* prefers to live in areas which have relatively high humidities in spring and early summer; warmth produced by the sun on the vegetation bringing them out, often in hundreds. The height of such vegetation seems unimportant, provided it is not dense and sunlight can penetrate down to the soil surface, in general however, a low growth seems preferable. *V. angustior* rarely climbs up the vegetation to any height, preferring to stay within a few centimetres of the soil surface, it is therefore more difficult to locate than other *Vertigos*; this may account for the scarcity of records in otherwise suitable areas. Animals and plants that occur in marshes are as a general rule not particularly affected by light frosts; *V. angustior* is, however, of southern and western distribution and may be affected adversely. This could help to account for its virtual extinction in England and its apparently restricted distribution in Ireland.

DISCUSSION

The occurrence of single specimens of *Vertigo* in any particular habitat usually means that the recorder is collecting in the wrong place or the mollusc is a stray. Newly established habitats or localities in which a species is dying out produce limited numbers, but always it can be shown that they belong to a colony. In very dry or cold weather *Vertigos* can be very difficult to locate, their small size enabling them to seek refuge in small and often inaccessible places. All the British species of the Vertiginidae can be, and have been, found alive in very large numbers, usually in a relatively small and compact area. This is essential for the survival of any small, slow moving animal in which sexual reproduction takes place.

It is unlikely that any small species could survive unless it was present in large numbers. Care should always be taken therefore when a habitat is described based on a single specimen. The recording of rare species of Mollusca from river rejectamenta should also always be done with great care, particularly when the river is large and fast flowing. Gastropods, when dead, often contain a quantity of gas as a result of the animals decay, or air, which makes the shell buoyant. In this condition, an empty shell can travel over great distances to be deposited on the banks, perhaps even in a different county from its source. Fossil specimens washed out of some deposits can look remarkably fresh when gathered from rejectamenta, particularly when they are compared with badly preserved specimens of recent origin.

In Ireland, *V. angustior* is probably very much more widely distributed in a living state than the records suggest. An examination of suitable habitats on the central plain would most likely widen its known distribution in that area. Its small size and the shortage of workers in Ireland must be taken into account when assessing its distribution. The site at Flordon Common in East Anglia may also be only one of a number of localities in that area, an examination of other commons of similar age and type may prove productive. Many other localities have been listed for *V. angustior* by authors in the past, when trying to give its

range and distribution. Of these localities, Oxwich Dunes in Glamorgan is the only one on which a study has been made (Quick, 1925, 1926, 1927). All the specimens of *V. angustior* found were of fossil origin, but its occurrence in damp areas on similar dune systems in South Wales cannot be ruled out.

The type of habitat in which *V. angustior* occurs would make it relatively easy to preserve should this become necessary, however, at the moment we can see no reason to suspect that it is in any more danger of becoming extinct in Britain than it was 100 years ago.

The preservation of Flordon Common as a reserve by the Norfolk County Trust, should this become feasible, would however ensure its survival in the only known English habitat and enable a study to be made of this rare and interesting species.

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AZECA IN BRITAIN

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INTRODUCTION

Some authors have recognised two (or more) forms of *Azeca* Fleming 1828 in Europe. *A. menkeana* (C. Pfeiffer, 1821) is said to be characterised by a shell with denticles deep within the aperture on the palatal wall while *A. goodalli* (Férussac, 1821) lacks these denticles. Furthermore *A. menkeana* was thought to be confined to the northern and eastern parts of the range of *Azeca* in Europe (i.e. N. France, Germany,) and *A. goodalli* to the southern and western areas (Pyrenées, Britain). In particular *A. menkeana* has not been reported alive in the British Isles although it is known as an interglacial fossil (Kerney, 1960).

Germain (1930) regarded *A. menkeana* and *A. goodalli* as specifically distinct and even recognised a third species without any palatal denticles at all, namely *A. bourguignati* Fagot. In contrast Pilsbry (1908 : 138) and more recently Kerney (1960 : 331) regarded the former pair as geographic subspecies on the basis of their apparently distinct geographic distributions. The discovery that all specimens of *Azeca* from Eversden Wood, Cambridge (Grid reference 52/341529) were typical *menkeana*, not *goodalli*, cast doubt on the geographic separation of the two forms and stimulated me to examine shells of *Azeca* from other British localities. This study lead to the following conclusions:

1. Shells of *Azeca* with some or all the *menkeana* denticles are common and widespread in Britain.
2. The arrangement of denticles and lamellae in British *Azeca* is very variable.
3. *A. menkeana* and *A. goodalli* cannot be separated as even subspecies.

The purposes of this note are to present these conclusions and to describe the variation in the dentition of British *Azeca*.

I am very grateful to Mrs. E. B. Rands of Luton, Beds., for the loan of many specimens and to Mr. John Peake for access to the collections of the British Museum, Natural History (BMNH). Mr. M. R. Block kindly guided me to *Azeca* localities in northern Hampshire and Mrs. Rands, at my suggestion, confirmed that the colony in Perthshire was extant on a recent trip to Scotland.

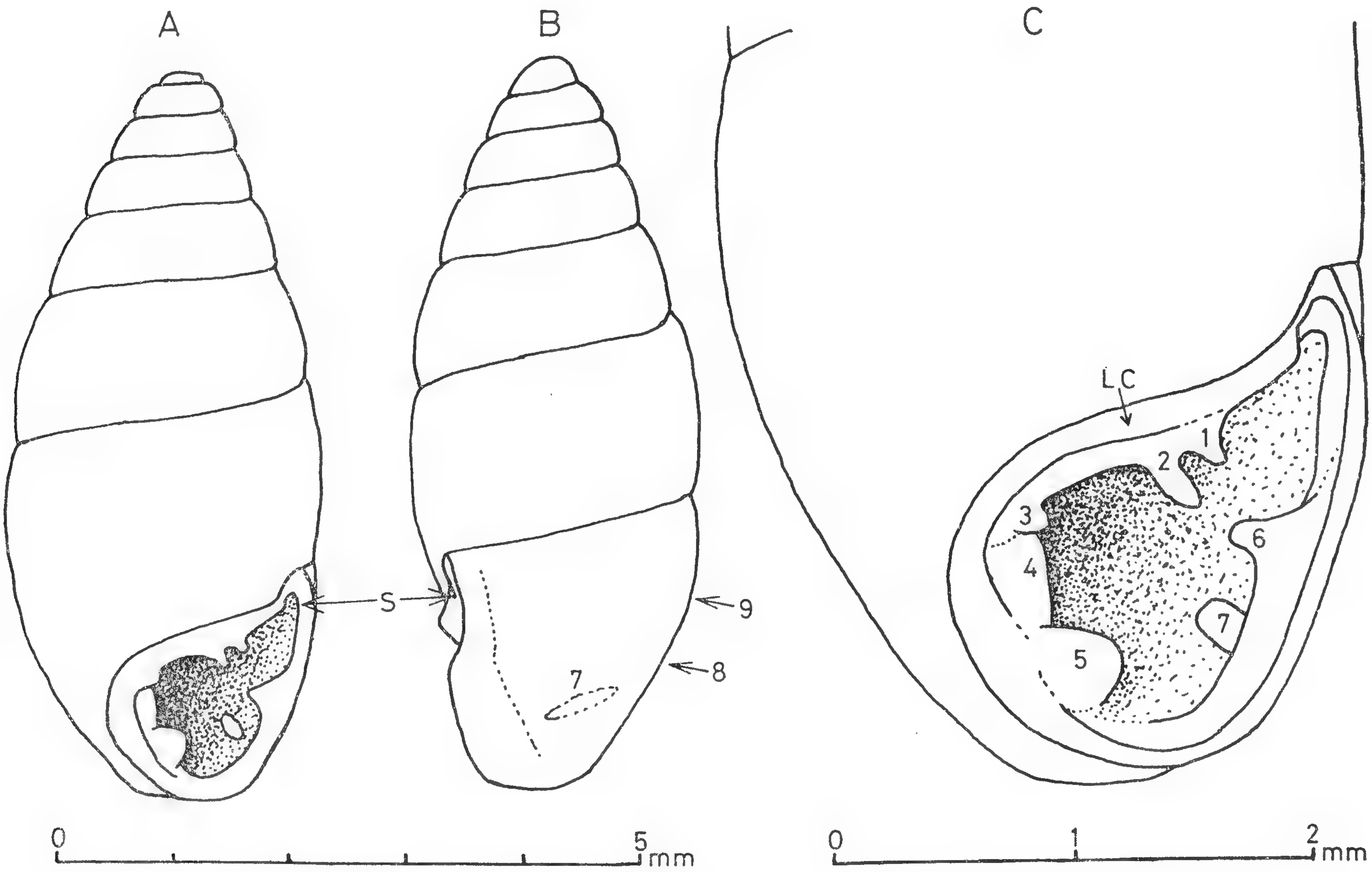
DESCRIPTION

Shells of *Azeca* are quite small (length $5\frac{1}{2}$–$6\frac{1}{2}$ mm, width $2\frac{1}{2}$ mm), very shiny and fusiform in outline (Plate V, figs. 2, 3, 10). They resemble those of *Cochlicopa*

but are distinguished *inter alia* by the presence of teeth in the aperture. As Pilsbry (1908) noted, the original name "*Turbo tridens*" is inappropriate not only taxonomically but descriptively as well: *Azeca* typically has at least six teeth and may have as many as nine or ten. Specimens which I have examined had teeth developed in 18 different locations, although no one specimen had all of them and some teeth are clearly just individual anomalies. In this paper I have used the following terms and notation:

"Denticle"	For a short, more or less circular tooth.
"Lamella"	For a long ridge-like structure.
"Tooth"	As a general term for both denticles and lamellae.

For convenience teeth have been numbered consecutively starting with the upper right parietal tooth and working round the aperture anti-clockwise (Fig. 1).



Text-fig. 1. Camera lucida drawings of *Azeca* to show the general shell outline and positions of apertural teeth. A & B Apertural and lateral views of the shell to show the sinus (S) and positions of teeth 7, 8 and 9. C Enlargement of body whorl to show positions of teeth 1–7 and the lip callus (L C).

The terms "fold" and "plica" are inappropriate to describe any of the teeth in *Azeca*.

The aperture (Fig. 1C): The external outline of the aperture in *Azeca* is sub-triangular, coming to a sharp angle at the upper right but gently rounded at the other two corners. The internal outline is divided into two unequal irregular areas by the main parietal lamella (2) and main palatal denticle (6) which are set opposite each other (Fig. 1A). In life the respiratory pore and anus open through the upper area while the body emerges through the lower area. The

aperture has a strongly developed lip of white callus which commences on the parietal margin about 0·1 mm to the left of the outer lip and is continuous at least down to the lower columellar denticle (5). In some specimens denticle 5 is connected to this lip by a distinct ridge (e.g. Plate V, fig. 9). In this case a slightly thinner lip continues to the lowest point of the aperture and then, regaining its original thickness, swings up to the main palatal denticle (6) where it ends. In other examples the lip is a continuous band which runs without interruption from the upper right parietal margin right round to the palatal denticle (Plate V, fig. 2). Above the palatal denticle the outer lip is thinner, sharp-edged and has much less callus lining it (Fig. 1C, plate V, fig. 2). On the parietal margin the lip callus turns upwards (i.e. towards the apex) and thins before reaching the thin upper part of the outer lip (Fig. 1C, plate V, fig. 2). A narrow sinus is thus formed. Viewed from the side it can be seen that growth of the outer lip was arrested slightly earlier above than below the palatal denticle (Fig. 1B, plate V, fig. 3). The various teeth are as follows:

1. Either a denticle or a lamella which may be circular or elongate. In the latter case it may lie at any angle to the main parietal lamella (2) from perpendicular to parallel but is usually oblique (e.g. Plate V, fig. 9). In many examples it is strongly curved or angled and is partly parallel and partly oblique. It may connect directly with, just touch or be entirely separate from either or both the parietal lip callus or lamella 2. It much more commonly touches the former than the latter (Table 1).

TABLE 1. VARIATION IN TOOTH 1

DISCRETE	TOUCHING PARIETAL LIP CALLUS	TOUCHING 2	TOUCHING BOTH 2 AND LIP CALLUS	TOTAL
84	71	1	3	159
52·83%	44·65%	0·63%	1·89%	100%

2. The main parietal lamella is always a prominent lamella in the middle of the parietal margin. It is the first tooth to develop, starting to form well before the outer lip is deposited (Plate V, fig. 4). It extends at least half a whorl back into the aperture where it may connect with the columella. Viewed from the side (only possible with a broken outer lip) the crest is uneven and usually has three high points, the central of which marks the thickest part of the lamella (Plate V, fig. 7). The main parietal lamella approaches the lip callus perpendicularly, swings abruptly away from 1 (i.e. to the left) and may connect with lamella 3 to form a single U-shaped lamella (Plate V, fig. 9). Alternatively there may be no connection or a few isolated granules of callus may form an incomplete connection. In mature shells the connection is usually complete although thinner than either lamella 2 or 3. However some mature shells show no trace of any connection (Table 2).

3. A distinct lamella at the parietal-columellar angle (Plate V, figs. 7, 9). It runs from just inside the parietal lip callus perpendicularly back to the upper

TABLE 2. CONNECTION BETWEEN TEETH 2 AND 3

CONNECTED	SEPARATE	TOTAL
115	44	159
72·33%	27·67%	100%

columellar lamella (4) which it usually touches. 3 may be smooth and straight. However in some examples it is curved in an S-shape: in others irregular and it may be formed by the coalescence of several callus granules. 3, like 2, never touches the parietal lip callus.

4. The upper columellar lamella runs straight down the columella from high inside the body whorl and terminates behind 5. It is not twisted, is usually thickest where lamella 3 touches it (Plate V, fig. 7) and may be abruptly truncated below. In immature shells (Plate V, fig. 4) it is narrow and has a gently curved outline. When fully developed it is much thicker and may have an angular profile. Both 4 and 5 start to develop before the outer lip.

5. The lower columellar tooth may be a simple sharp denticle at the base of the columella (e.g. Plate V, fig. 2). Alternatively it may form a short lamella set obliquely across the base of the columella and more or less distinctly connected to the lip callus by a ridge (Plate V, figs. 5, 9).

6. The palatal (outer lip) denticle is typically a sharp tooth set opposite the main parietal lamella (2). It marks the upper limit of the thickened outer lip callus and the lower limit of the sinus (Plate V, fig. 2). It may extend a short distance back into the aperture.

All the above teeth are present in all but two of the mature shells that I have examined. These six alone are said to characterise *A. goodalli.* The following three teeth may or may not be developed (Table 4) and supposedly characterise *A. menkeana.*

7. An internal lamella, denticle or merely a callus deposit which lies just inside the outer lip and below the palatal denticle (6). It may be entirely separate from the outer lip callus (Plate V, fig. 5) or connected to it and is usually elongate perpendicular to the outer lip. Table 3 illustrates the degree of development of tooth 1 in a sample of 161 specimens.

TABLE 3. DEVELOPMENT OF TOOTH 7

DISTINCT TOOTH	THIN CALLUS DEPOSIT	ABSENT	TOTAL
51	51	59	161
31·6%	31·6%	36·8%	100%

8. The lower internal denticle developed about $\frac{1}{4}$ to $\frac{1}{3}$ of a whorl back from the outer lip and only just visible through the aperture. It is a circular or oval denticle often associated with another similar and usually smaller denticle (9) immediately above it (Plate V, fig. 11). 8 may occur by itself (Plate V, fig. 1).

9. The upper internal denticle is a small circular or oval tooth slightly in front of

(i.e. nearer the aperture) and just above 8 (Plate V, figs. 6, 11). When 8 and 9 are oval their long axes are not quite parallel to the suture but slope slightly up towards the aperture. Table 4 indicates the frequency of teeth 7, 8 and 9 in a sample of 485 shells.

TABLE 4. OCCURRENCE OF "*MENKEANA*" TEETH

1–6 ONLY	7	8	9	EITHER OR BOTH 8 AND 9	TOTAL
248	194	93	51	96	485
51·13%	40·0%	19·18%	10·52%	19·79%	

(The percentage values do not total 100% since one shell may have more than one of the "*menkeana*" teeth).

In addition to the above nine teeth which are present in significant numbers of shells, the following may occur but usually only as individual anomalies:

1a. An additional denticle beside tooth 1 seen in a single shell from Addington in Warfedale (BMNH).

2a. A short lamella parallel to the main parietal lamella (2) and between 2 and 3 but much nearer the former. Seen in one shell from near Ecchinswell, Hants. (41/491598).

3a. A small irregular lamella touching 3 near the outer edge and running to the base of 4. Present in a single shell from Chalton Spinney, Fancott, Beds. (52/0227).

5a. A swelling or incipient denticle at the very base of the aperture on the outer lip callus (Plate V, fig. 12). Found in one shell from Chalton Spinney.

6a. A hint of thickening or callus deposit (which never develops into a true tooth) inside the outer lip *above* the palatal denticle (6). Present in about 15·5% of a sample of 161 specimens.

6b. A hint of callus directly behind tooth 6. Present in one shell from Romily, Cheshire (BMNH).

8a. A small circular denticle below 8 (Plate V, fig. 6) present in two specimens from Dedmansey Wood, Studham, Beds (52/0317) and one specimen each from Elmorepark Wood, Woodcote, Oxford (41/635814) and Eversden Wood, Cambridge.

9a. A small circular denticle above 9 found in a single shell from Eversden Wood.

9b. A large circular callus deposit fully ½ whorl back from the aperture and well behind denticle 8 (Plate V, fig. 8). Found in a single shell from near Ecchinswell, Hants.

The sample of *Azeca* available to me was not exhaustive and included about 500 British and 25 foreign shells. Doubtless additional teeth will be discovered if sought for.

VARIATION

Clearly from the above description both the number and arrangement of teeth

in the aperture of British *Azeca* are very variable. Before *A. menkeana* and *A. goodalli* can be accepted as even subspecies it is necessary to demonstrate 1) that there is some consistent morphological distinction between them and 2) that they differ in their ecology or geographic distribution. Variation of teeth, size and colour have been investigated to see if two forms of *Azeca* can be recognised.

a. Teeth: *A goodalli* is supposed to have shells with only teeth 1–6: *menkeana* shells with all nine principal teeth. In this discussion the accessory teeth may be ignored since they are merely individual variants of no taxonomic significance. I have seen only two mature shells with any of teeth 1–6 absent (one from Ilkley, Yorks with tooth 3 missing, and one from Purley, Surrey without tooth 1) but certainly nothing which corresponds with Germain's description of *A. bourguignati* Fagot (Germain 1930: 455). Table 5 shows the numbers of shells seen with each of the eight possible combinations of six to nine teeth. At least one shell occurs in each category although some are so rare as to be negligible. Over half of the 485 British shells in table 5 have only teeth 1–6 and would seem to be typical *A. goodalli*. However table 4 shows that twice as many shells have tooth 7 as have either or both 8 and 9. Furthermore of the 96 shells which do have 8 and/or 9 just over half (53, 55·2%) have tooth 7 while just under half (43, 44·8%) lack it. Clearly the development of tooth 7 on the one hand and teeth 8 and 9 on the other hand are quite independent and British shells do not fall into two categories with six and nine teeth.

TABLE 5. OCCURRENCE OF POSSIBLE TOOTH COMBINATIONS

1–6 only	7	8	9	7+8	7+9	8+9	7+8+9	TOTAL
248	141	23	1	22	2	19	29	485
51·13%	29·07%	4·74%	0·21%	4·54%	0·41%	3·92%	5·98%	100%

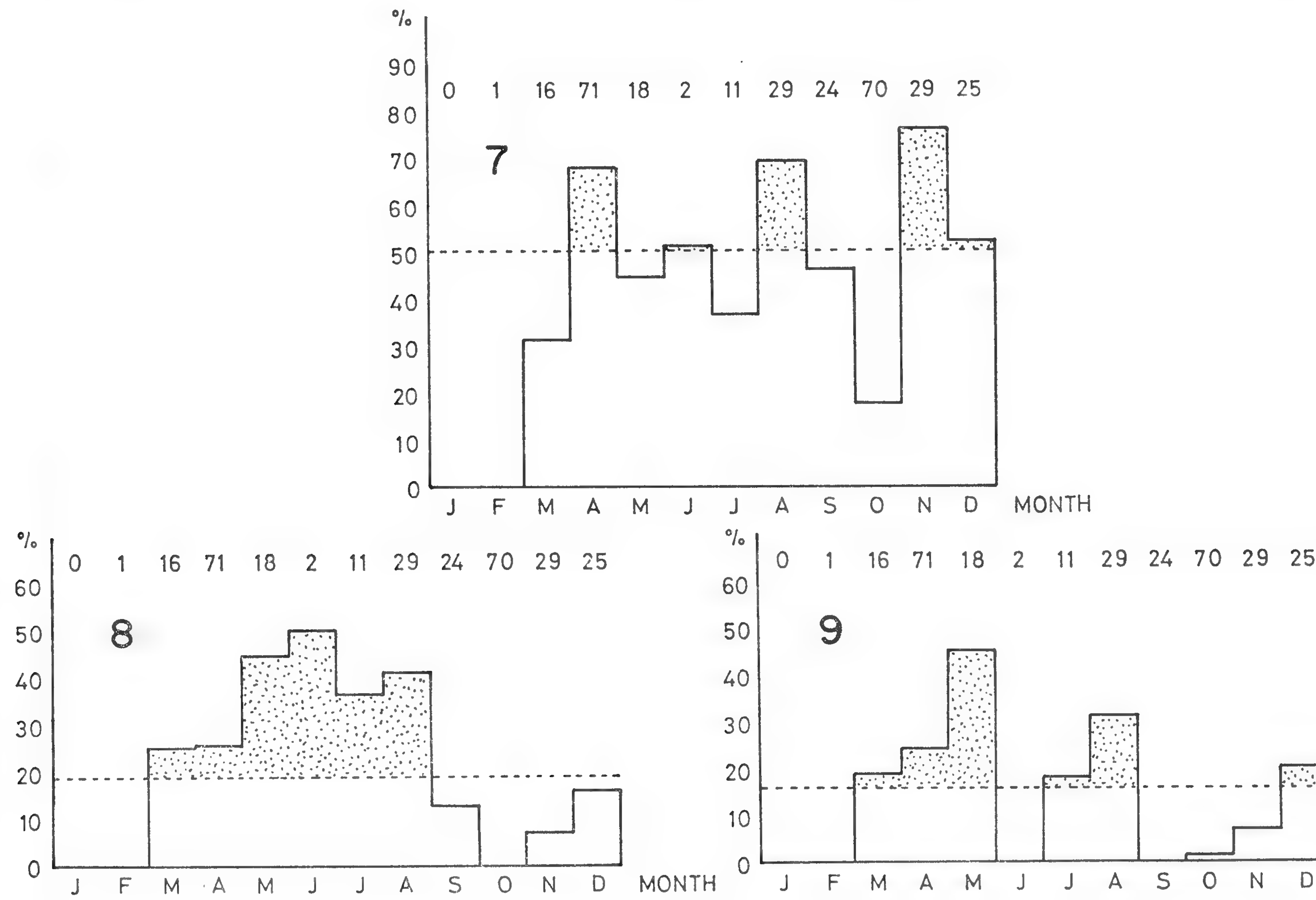
The following two suggestions may help explain the large variation in dentition found among British *Azeca*.

i) The precise arrangement of teeth in *Azeca* is probably genetically determined and seems to be characteristic of particular colonies. This is not surprising when one considers the extremely local and isolated occurrence of *Azeca* in Britain. Several examples may be cited in support of this contention. All four shells from Welton, Northants (42/5765) have 7 very strongly developed as do the majority of shells from Amersham, Bucks (BMNH). However, generally 7 is only weakly developed when present in British shells. All shells from Eversden Wood, Cambridge have 8 and 9 fully developed, but 7 is generally weak or absent. The majority of shells from Barton Springs, Beds. (52/0829) have 6a and 7 developed as very weak callus deposits, but 8 and 9 are entirely absent. Finally 47 of 50 shells from Box Hill, Surrey (BMNH) have no trace of 7, 8 or 9. Within all these colonies the arrangement of teeth varies little but there is considerable variation between them.

ii) Snails with modified apertures usually produce the modifications at the final stage of growth, although callus may continue to be deposited after the shell has ceased to increase in size. The absence or weak development of some

teeth in some individuals may simply be due to incomplete growth. I have therefore tried to establish the order in which teeth form and to detect any seasonal variation. Eight shells have been seen with incompletely developed apertures but with some teeth present. These indicate that the main parietal lamella (2) develops first followed by the two columellar teeth (5 then 4, apparently), all three of which start to develop long before the outer lip forms. 1 and 3 follow and may also start to form before the outer lip or tooth 6. 7 may start to develop before 6 has finished forming while 8 and 9, despite occurring well back behind the lip, are the last to appear, perhaps some months after the others. Usually 8 is larger than 9 and it is more common than 9, both of which suggest that 8 develops before 9.

With regard to seasonal variation, table 6 and text-figure 2 summarise available data from samples, the month of collection of which is known. Apparently shells with teeth 7–9 have been found during almost all months for which records exist.



Text-fig. 2. Seasonal data on presence of teeth 7, 8 and 9 in *Azeca*. Each graph shows the percentage of shells which have a particular tooth (i.e. 7, 8 or 9) developed for each month of the year. The dotted horizontal line represents the mean percentage of all shells. Figures at the top represent numbers of shells in each monthly sample. Above average percentages are emphasised by stippling. Seasonal development of teeth should result in a pattern that is consistently above average at one time of year and below average for the remainder of the year. Tooth 7 does not display such a seasonal pattern but teeth 8 and 9 apparently do. Samples for January (N = O), February (N = 1) and June (N = 2) are too small to be significant and should be ignored.

The small samples for January and February probably reflect collection failure: that for June may represent a combination of dry weather and rank vegetation cover. The high total for April probably reflects ease of collection (vegetation is still low and the ground still damp after winter) while that for October is an artifact of a single sample of 50 shells from Box Hill, Surrey. Since this last sample contained 47 shells with only teeth 1–6 the October percentage values for teeth 7, 8 and 9 are biassed on the low side.

TABLE 6. PRESENCE OF "*MENKEANA*" TEETH THROUGHOUT THE YEAR

MONTH	J	F	M	A	M	J	J	A	S	O	N	D	TOTAL
TOOTH													
1	1	1	16	70	18	2	10	29	24	70	28	25	293
2	1	1	16	71	18	2	11	29	24	70	29	25	296
3	1	1	16	70	18	2	10	29	24	70	28	25	293
4	1	1	16	70	18	2	10	29	24	70	29	25	294
5	1	1	16	70	18	2	10	29	24	70	29	25	294
6	1	1	16	70	18	2	10	29	24	69	29	25	293
7	1	–	5	48	8	1	4	20	11	13	22	13	145
8	–	–	4	18	8	1	4	12	3	–	2	4	56
9	–	–	3	17	8	–	2	9	–	1	2	5	47
TOTAL SPECIMENS	1	1	16	71	18	2	11	29	24	70	29	25	296
%7	100	0	31·3	67·6	44·4	50·0	36·4	69·0	45·8	18·6	75·9	52·0	49·0
%8	0	0	25·0	25·4	44·4	50·0	36·4	41·4	12·5	0	6·9	16·0	18·9
%9	0	0	18·8	24·0	44·4	0	18·2	31·0	0	1·4	6·9	20·0	15·9

Once again tooth 7 and teeth 8 and 9 differ. No definite trend appears for tooth 7. However both 8 and 9 tend to be above average from March to August and below average but with increasing values from September to November or December (Fig. 2). This implies, *but by no means proves*, that teeth 8 and 9 are secreted in the last quarter of the year and that adults with these teeth die towards the end of summer. Juveniles without teeth have been collected in May, July and December: juveniles with incomplete sets of teeth in July, September and November.

While data are insufficient to be certain, they suggest that many shells mature and form teeth 1–6 late in the summer while teeth 8 and 9 are mainly added later the same year or early the following year. Detailed study of several colonies with the "*menkeana*" teeth will be needed to confirm this suggestion but possibly a shell may be typical "*goodalli*" in the third quarter of a year and typical "*menkeana*" by the end of the first quarter of the next year. I have collected two samples from the same colony in Hayley Wood, Cambridge which tend to support this contention. Only one of 14 adult shells collected on 3 December 1970 had tooth 8 present while 4 of 6 collected on 28 April 1972 had this tooth. However in contrast all shells in three collections made at the same site in Eversden Wood only 3 miles away had both 8 and 9 present. These collections were made in May and December 1971 and March 1972. Specimens from Elmorepark Wood suggest that the order in which teeth form may not be constant even within a single colony. One shell has 8 and 9 only weakly developed and a fully formed outer lip while another has 8 and 9 strongly developed as well as a weak tooth 8a yet the outer lip is thin and tooth 6 weak.

To summarise: British *Azeca* do not fall into two groups with 6 and 9 teeth respectively. In particular the development of tooth 7 and of teeth 8 and 9 are

independent of each other. Available evidence suggests that teeth 1–6 (± 7) develop relatively rapidly at the final stage of growth while teeth 8 and 9 are usually added after the shell has reached its final size and the aperture has been completely formed, perhaps some months after.

The arrangement of teeth does not seem to be a good character on which to separate *A. goodalli* and *A. menkeana,* in particular the status of tooth 7 is equivocal. Size and colour variation were therefore investigated in relation to tooth arrangement.

b. *size* : The shells of *Azeca* like those of any other snail, vary in size and colour. Kerney (1960: 331) noted that his British fossil *Azeca* not only had the "*menkeana*" teeth (7–9) but were also "slightly and consistently smaller" than living "*goodalli*" from Britain. Ehrmann (1956 : 33) also mentions a smaller fossil form from Germany as *A. menkeana schulziana* Wüst. "Eine etwas kleinere Form mit stark entwickelten Lamellen u. Falten war im Diluvium in Deutschland weiter verbreitet: *A. m. schulziana* Wüst." Possibly Kerney's fossil *Azeca* were of this form which may well be a valid subspecies. However Zeissler (1968) has shown that the size range of recent *Azeca* from Thuringia overlaps that of fossil *A. schulziana.*

A sample of 157 British shells from 20 different localities was measured to investigate the possibility that size and tooth variation might be linked. The sample was divided in "*menkeana*" and "*goodalli*" in two ways. First all shells with any trace of 7, 8 or 9 were included in "*menkeana*", and secondly only those shells with traces of 8 and 9 were included in this group. The results are summarised in table 7 which shows *inter alia* that living British "*menkeana*" are consistently longer than "*goodalli*" irrespective of which way these two groups are defined. This is the opposite of the fossil forms. Width is significantly greater in "*menkeana*"

TABLE 7. DIMENSIONS OF '*MENKEANA*' AND '*GOODALLI*'

DIMENSION	STATISTIC	"*MENKEANA*" 8 & 9 only (N = 39)	"*GOODALLI*" 1–7 (N = 118)	"*MENKEANA*" 7–9 (N = 112)	"*GOODALLI*" 1–6 (N = 45)
LENGTH (L)	$\bar{L}$	6·0150	5·9462	5·9850	5·9000
	s_L	0·2058	0·2122	0·2023	0·2160
		T = 1·787		T = 2·354	
		*P = 5–10% (90–95%)		P = 2% (98%)	
WIDTH (W)	$\bar{W}$	2·5737	2·5450	2·5500	2·5554
	s_W	0·0630	0·0619	0·0637	0·0643
		T = 2·534		T = – 0·486	
		P = 1–2% (98–99%)		P = > 50% (< 50%)	

* In this table P is the probability of obtaining two samples with the observed difference in mean values from the same (statistical) population. It may equally well be expressed as the probability that the two samples came from different (statistical) populations and these values are given in parentheses.

only if the latter is defined as having teeth 8 and 9. The levels of statistical significance of the observed differences were tested using Student's t-test and are surprisingly high in three cases (Table 7). However the highest levels of significance occur comparing mean width with "*menkeana*" defined one way, and mean length with "*menkeana*" defined the other way. Neither way of defining "*menkeana*" seems preferable. In the case of *Azeca* I think that a high level of statistical significance does not indicate a correspondingly high biological significance. However there is a general correlation between size and number of teeth: shells with most teeth are longest.

Zeissler (1968) specifically ignored dentition when investigating size variation. From the point of view of the present study this is unfortunate. Her overall results were:

	Length	Width
Min.	5·2 (5·36)	2·2 (2·40)
Max.	6·9 (6·66)	2·8 (2·70)
Mean	6·0	2·5
	N=147 (166)	

Figures in parentheses are corresponding values for British shells which apparently show a little less size variation than Zeissler's material. In the BMNH collections is a single anomalous specimen labled "*Azeca elongata* Taylor" which is 8·92 mm. long, 2·74 mm wide and has over 8 whorls. It is from Ingleton, Yorks and may well have been parasitised.

c. Colour: Shells of *Azeca* display two marked colour variants although intermediates do occur rarely. Most fresh shells are a uniform chestnut brown but the var. *crystallina* Dupuy is white and translucent. Dupuy described this variety as a form of his *A. nouletiana* which comes from the Pyrenées and is also said to lack teeth 7–9 (i.e. it is a junior synonym of *A. goodalli.*) Again there is some correlation between variation in colour and dentition. White shells with teeth 7–9 are very rare, however one white shell from Elmorepark Wood has both 8 and 9, the latter only weakly developed, while two examples from Adbury Park Farm, Hants (41/491628) and four from Brook's Wood, near Frant, Sussex (BMNH) have 7 and/or 8 developed. Var. *crystallina* has no real taxonomic status. *A. goodalli* is another species in which white (semi-albino) individuals occur not uncommonly. The white forms of *Azeca* have no more significance than those of *Retinella pura, Acicula fusca, Lauria anglica* etc.

BIOLOGICAL SIGNIFICANCE OF DENTITION IN *AZECA*

Most of the teeth in *Azeca* are developed in the aperture which is the last formed part of the shell. It is worth considering briefly the significance to snails of their shell and its aperture. In *Azeca* and similar snails the shell accommodates the entire animal when it withdraws. Thus the shell has a considerable protective effect. Even when the animal is extended the shell still protects the visceral

mass which includes several vital organs. When withdrawn snails cannot feed or reproduce and the aperture enables them to emerge for these activities. In contrast respiration must continue whether the animal is extended or withdrawn. The aperture enables snails to breath in both cases. For total protection the shell should completely enclose the soft tissue without any gaps but that would prevent feeding, breathing, reproduction etc. The aperture enables these activities to be performed, but reduces protection since it is a large hole through which potential predators may enter the shell. The aperture is thus a compromise between the everyday vital needs of the snail and the requirements of efficient protection. Modifications to the aperture may be viewed in this context. In many snails an operculum completes the protection afforded by the shell, in which case the operculum should fit tightly and effectively seal the aperture. Terrestrial operculate snails, especially those living in markedly seasonal climates with prolonged dry spells, frequently develop special respiratory structures in response to the sealing effect of the operculum (Rees, 1964). Snails without opercula may press the aperture as close as possible to a solid object when they withdraw, completing the protective effect of the shell in this way. This probably accounts for the downward turn of the body whorl at the aperture in many heliciform snails. The resulting oblique aperture can be pressed more closely to a flat surface.

Several plausible effects may be suggested for modified apertures in terrestrial snails: e.g. strengthening the aperture; reducing the area of the aperture to prevent entry of predators (protection) or to reduce water loss during hibernation and/or aestivation; aiding carriage or orientation of the shell while the animal is extended. Doubtless different types of dentition have different significances to the snails that bear them. It is hard to imagine that the dentition of the Vertiginidae, which have cylindrical shells $1\frac{1}{2}$–$2\frac{1}{2}$ mm long, evolved in response to the same needs as that of the Polygyridae which have disc-shaped or globular shells 10–35 mm in diameter. Each case should be investigated separately, nevertheless one or two general statements seem to be valid and I shall consider these generalizations before discussing *Azeca* in detail.

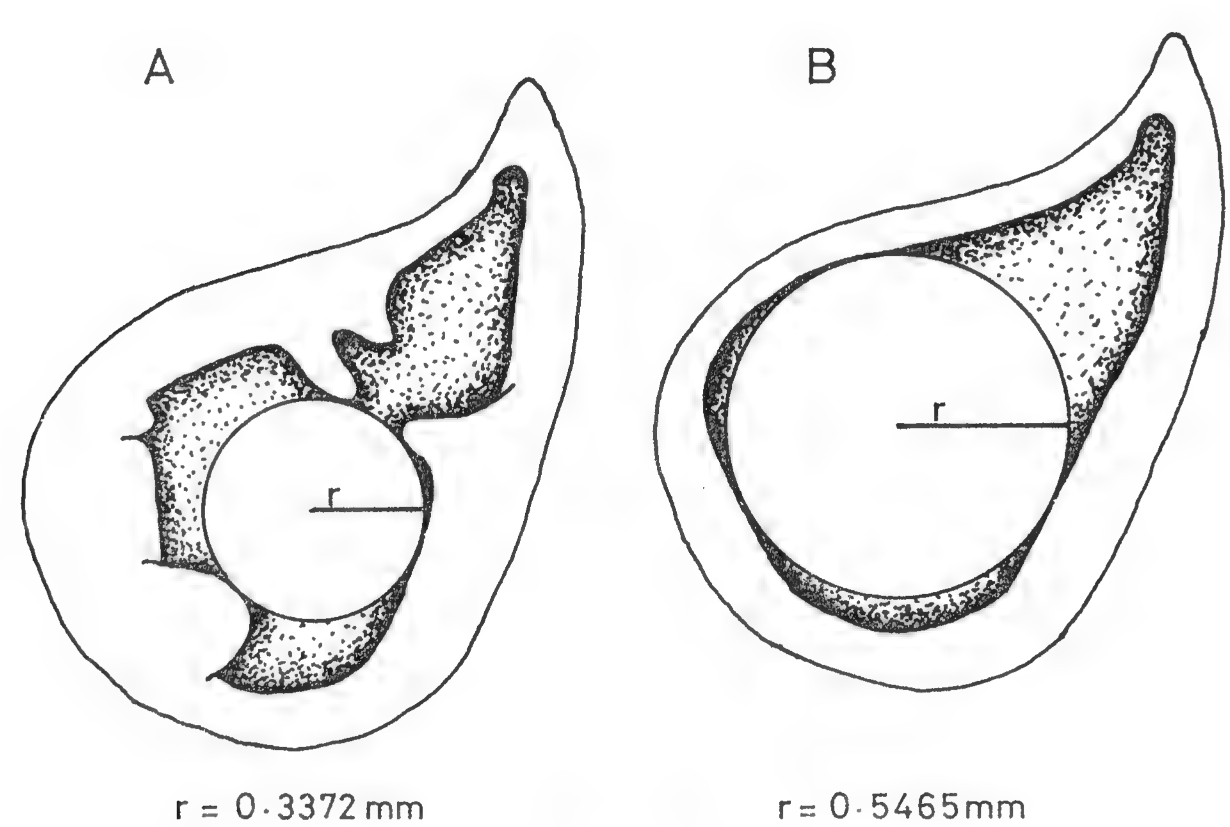
If the dentition of *Azeca* and similar snails was of any use only the adults benefitted from it. This is very commonly the case with modified apertures and it requires that there be a fixed adult size beyond which the shell does not grow. (I am aware that many marine snails, the Muricidae for example, modify their aperture repeatedly during growth but this is very uncommon (?unknown) in terrestrial snails and certainly was not the case with *Azeca*.) A few terrestrial snails do modify the aperture in the juvenile stages: *Lauria cylidracea* has more complex modifications throughout growth than at the adult stage.

If only adult snails benefit from modified apertures such snails might be expected to have a prolonged adult life. There seems little advantage to a snail which lives for twelve months in having a modified aperture for the last few days or weeks of life unless the modifications were directly associated with mating or oviposition etc. If however, like humans, the adult snails survive for 2–3 times as long as they take to reach maturity there would be considerably greater advantage in

having a modified aperture. Unfortunately I have no direct evidence on the longevity of *Azeca* in natural surroundings. I will now consider the suggested effects in turn and it will become apparent that none of them adequately explains all the teeth in *Azeca*.

A. *Strengthening the aperture*. There is no doubt that in *Azeca* the thick lip callus greatly strengthens the aperture although this effect is less marked on the outer lip in the region of the sinus. Many snails which lack any teeth (e.g. *Cepaea*) modify the aperture by producing an inner "rib" which lines the aperture and undoubtedly strengthens the outer lip. Other snails produce a constriction of the whorl immediately behind the aperture (with or without a rib as well). This constriction has the same strengthening effect. If strengthening were the only effect of the modifications to the aperture in *Azeca*, the lip callus would be sufficient by itself. Furthermore teeth 2–4, 8–9 and sometimes 7 as well, do not touch the lip callus and cannot be associated with its strengthening effect.

B. *Protection*. Teeth which project into an aperture may reduce the maximum size of any organism that can pass through the aperture and thus keep potential predators out of the shell. In this connection it is significant that terrestrial snails with opercula generally lack inwardly projecting teeth. In the first case these teeth would get in the way of the operculum, secondly the operculum itself is an efficient protective device and (in land snails) completely fills the aperture. An estimate of the theoretical protective effect of teeth can be made by comparing the radii of the largest spheres which could pass through apertures of identical size with



Text-fig. 3. "Protective" effect of teeth in *Azeca*. A illustrates the maximum sphere that will pass through the aperture of *Azeca*. B shows the maximum sphere that would pass through if there were no apertural teeth. Both figures based on camera lucida drawings.

and without teeth. Text-figure 3 shows such an analysis for *Azeca*. Teeth 2, 5 and 6 effectively reduce the radius of the maximum sphere to 2/3 the "unprotected" value. Clearly these three teeth do have a protective effect (as defined here) but I have no evidence that this was of any benefit to *Azeca*. Even if it were beneficial

only teeth 2, 5 and 6 produce the effect, so why do shells of *Azeca* have between six and nine teeth? If teeth in general were protective devices they would be most efficient when disposed opposite each other at the aperture. In *Azeca* teeth 4, 7, 8 and 9 lie well within the aperture and, with the possible exception of the first, cannot be efficient protective devices, nor do they contribute to the protective effect of teeth 2, 5 and 6.

C. *Water conservation*. When withdrawn into its shell a snail loses water from the mantle collar surface, which has an area very close to the cross sectional area of the whorl at the resting point. Rate of water loss should depend on the area of the mantle collar and the relative humidity of the adjacent air. Resting snails usually secrete an epiphragm at the aperture and then withdraw a short distance. Block (1971) has shown that the epiphragm is not water tight but porous and Machin (1966) that at least *Helix aspersa* is able to reduce water loss physiologically. It seems unlikely that simple mechanical constriction of the aperture would seriously affect the rate of water loss in a resting snail although Rees (1964 : 58) remarks that it does. *Azeca* tends to inhabit damp mossy stations in which the external relative humidity remains fairly high and this would tend to reduce the rate of water loss. Finally if the presence of teeth effectively reduced the rate of water loss one would expect all xerophile snails to have such teeth and clearly many (?most) do not.

D. *Orientation and locomotion*. Modified apertures may help to orientate the shell on the snail's back while it is crawling. They may also enhance the leverage of the columellar muscles facilitating rapid changes in shell orientation. Ellis (1926 : 167) states that *Azeca* carries its shell parallel to the hind foot while *Cochlicopa*, which lacks teeth but is otherwise identical to *Azeca*, holds the shell obliquely. The parallel orientation of the shell in *Azeca* would be advantageous when moving in confined spaces such as a clump of dense moss. I can confirm that *Cochlicopa lubrica* and *C. lubricella* both carry their shells at an angle of 20–30° to the horizontal over the hind foot whereas *Azeca* often holds the shell parallel to the ground and over the foot. None of the three species appears to carry the shell at an oblique angle to the anterior-posterior line. *Azeca* can crawl in any direction with respect to the shell, including backwards underneath it. The possession of teeth does not restrict twisting of the body within the aperture. I have seen *Azeca* rotate the body through 360° without moving its shell at all.

To summarise: conclusive evidence in favour of any of the suggested effects is lacking and a combination seems more likely. The lip callus undoubtedly strengthens the aperture; teeth 2, 5 and 6 have a "protective effect" although it is not certain that *Azeca* suffers from the type of predation envisaged; teeth 2 and 6 separate the anal and respiratory orifices from the path of emergence of the body; and tooth 4 with the sinus may help in maintaining a suitable shell orientation when crawling. Once again it becomes apparent that the apertural and internal teeth differ in their significance. Morphological features which are not subject to selection may vary randomly. Fingerprints are sometimes cited as an example. Those features which are subject to the greatest selective pressures

will vary least. The apertural teeth of *Azeca* may confer some benefit on the snails and they are virtually always present. Selection for their development would seem to be strong. In contrast the internal teeth apparently confer little or no benefit and may or may not develop. Of the apertural teeth, 1 and 3 seem to be least significant, are most variable in shape and on very rare occasions they also fail to develop. The extreme variability of dentition in *Azeca* with regards to additional teeth suggests that these teeth are also not vital to the snails. The presence of the main teeth (1–6) probably confers some benefit on the snails but all the other teeth seem to be largely insignificant. Certainly it is not possible to argue from present data that snails with six and nine teeth are adapted to different ecological niches, modes of life, etc.

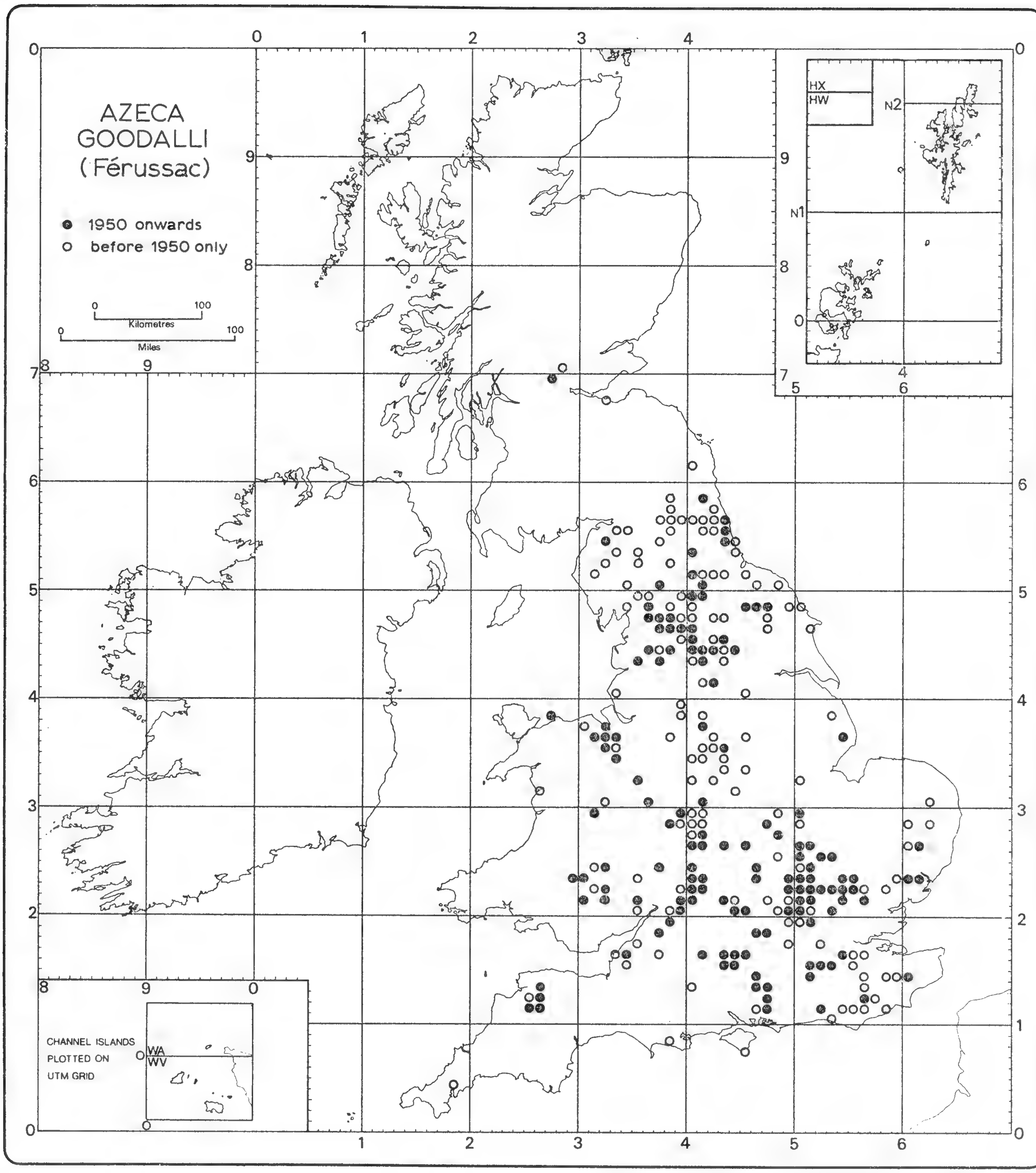
ECOLOGY AND DISTRIBUTION

Azeca occurs in woods, hedges and scrub, with a fairly dense growth of ground vegetation. It prefers damp situations on calcareous soil, often occurring under a dense mat of moss. In such situations it is not significantly affected by frost. On 31 December 1970 all specimens seen were active even though the ground surface was frozen solid and the temperature had not risen much above freezing for the previous week. Wherever I have found it, *Azeca* is extremely local in occurrence. Colonies extend over small areas even in wide expanses of apparently suitable habitats. For example *Azeca* is known from two isolated colonies in Hayley Wood, Cambridge. One extends over an area 25 m in diameter, the other has not been proved over more than 4 m^2 but must surely be larger than this. Hayley wood extends over 120 acres (approximately 480,000 m^2) much of which seems ecologically suitable judging from conditions at the known sites. However the snail has not spread beyond its narrow confines. Laboratory observations of living *Azeca* indicate that it is a very timid and hesitant snail. If this behaviour is typical in the wild it would help explain the very slow rate of migration of *Azeca* colonies and hence their very local occurrence.

Azeca is not uncommon throughout central and southern England and eastern Wales (Fig. 4). It becomes rarer in the south-west of England and in East Anglia. An isolated colony has been known from Perthshire in Scotland since 1896 (Taylor and Roebuck Manuscripts, BMNH) and is still extant (1972). *Azeca* is absent from Ireland. Forms with some or all the "*menkeana*" teeth are almost as widespread as those without. In Britain shells with and without the "*menkeana*" teeth occur together quite commonly and show no ecological preferences that I can detect. Körnig (1966, figs. 10 and 19) gives maps of the central German and European distribution of *Azeca*, although in the latter he overlooks Venmans' (1959) record of *Azeca* from the Italian Dolomites.

TAXONOMIC STATUS OF THE VARIATIONS

As regards dentition, British *Azeca* show no clear cut division into two forms but a more continuous variation. Apparently this is linked with size and colour variation both of which are also transitional at least as regards populations. If the



Text-fig. 4. A map showing the distribution of *Azeca* in Britain.

statements about the distribution of tooth and colour variants in Europe are accurate a cline exists. The proportion of individuals with teeth 8 and 9 is highest in the north and east, lowest in the south and west. Conversely the proportion of pale forms increases in the south and west. In this case European *Azeca* belong to a single variable species.

Where two morphological variants occur their biological significance can best be determined by treating them as separate entities. Only by recording their distributional, ecological and morphological data separately will any significant differences be revealed. These differences can then be analysed and the variants

assigned to their appropriate taxonomic rank. This note is not an exhaustive treatment of *Azeca* in Britain and more data are needed. However British *Azeca* do not exhibit two distinct morphological variants. Separate recording of "*goodalli*" *and* "*menkeana*" forms is difficult and undesirable since it would obscure real variation. Records of the detailed dentition of colonies from all over the United Kingdom (and elsewhere in Europe) are highly desirable and I would be most grateful to see additional material of *Azeca*.

NOMENCLATURE

One final point arises as to the trivial name for the British *Azeca*. Férussac (1821) specifically referred to British shells (he was merely renaming the *Turbo tridens* of Pulteney, 1799) and so most British authors have used the name *A. goodalli* (Fér.). Pfeiffer described German shells and hence most Continental authors have used the name *A. menkeana* (Pffr., 1821). Pilsbry (1908) regarded the two forms as varieties and used the nomina *A. menkeana* and *A. menkeana* var. *goodalli,* on the grounds that Pfeiffer's description was the more complete and was accompanied by a figure. Férussac and Pfeiffer proposed their respective species in the same year, 1821. Kennard and Woodward (1926 : 144) refer to two editions of the relevant part of Férussac's work, the earlier of which dates from January 1821. Pfeiffer's work is just dated 1821. In the absence of the precise date of publication Pfeiffer's work must be taken as dating from 31 December 1821 (Article 21 (b), ICZN rules) while Férussac's must date from 31 January 1821. Hence *A. goodalli* takes precedence over *A. menkeana* and in fact the former name has been placed on the Official List of Specific Names in Zoology (Opinion 335, 1955).

CONCLUSIONS

Detailed examination of about 500 specimens of *Azeca* from Britain has failed to detect consistent morphological, ecological or distributional differences between the so-called "*menkeana*" and "*goodalli*" forms. Apparently in Britain, and by inference in Europe as well, only one species, which should be called *Azeca goodalli* (Férussac, 1821), exists.

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EXPLANATION OF PLATE V

Fig. 1. Dorsal view of body whorl to show single tooth 8. Hayley Wood, Cambridge.
Fig. 2. Stereophotos of the apertural (ventral) view to show fusiform outline of shell and aperture armed with teeth. Teeth 1 and 2 (on the parietal wall), 5 (at the base of the columella) and 6 (on the outer lip) show clearly. Traces of 3 (at the parietal-columellar angle) and 4 (behind 3 on the columella) can be seen by using a stereoscope. Note there is no tooth 7 (cf. text-fig. lc). Barton Springs, Beds.
Fig. 3. Stereophotos of lateral view of same shell to show the sinus, the shape of the outer lip and teeth 1, 2 and 3. Note that 1 connects with the parietal callus in this shell (cf. text-fig. 1b).
Fig. 4. Oblique apertural view of body whorl of an immature individual with only three teeth (2, 4 and 5) partly developed. Barton Springs, Beds.
Fig. 5. Stereophotos of apertural view of body whorl to show prominent tooth 7 inside the aperture (teeth 1–6 also show in stereoscopic view). Welton, Northants.
Fig. 6. Stereophotos of dorsal view of body whorl to show teeth 8a (below), 8 and 9 (cf. figs. 1, 8 and 11). Eversden Wood, Cambridge.
Fig. 7. Oblique lateral view of aperture with broken outer lip to show teeth 1–5. Note that tooth 2 has an angled crest and continues well back from the aperture, 3 touches 4 and the latter is untwisted and has a rounded outline. Dorking, Surrey.
Fig. 8. Stereophotos of dorsal view of body whorl to show teeth 8 and 9b (right margin, cf. figs. 1, 6, 11). Near Ecchinswell, Hants.
Fig. 9. Stereophotos of oblique apertural view of body whorl to show connection between 2 and 3 and truncated base of 4. Note that in this shell 1 touches 2 (cf. fig. 2). Welton, Northants.
Fig. 10. Dorsal view of whole shell to show outline and prominent tooth 7. Note that teeth 8 and 9 are absent. Welton, Northants. Same shell as fig. 5.
Fig. 11. Stereophotos of dorsal view of body whorl to show teeth 7 (lower left), 8 and 9 (cf. fig. 10). Welton, Northants. Same shell as fig. 9.
Fig. 12. Stereophotos of apertural view of body whorl to show tooth 5a (bottom, between 5 and 6). Chalton Spinney, Fancott, Beds. All photographs ×10.

Plate V

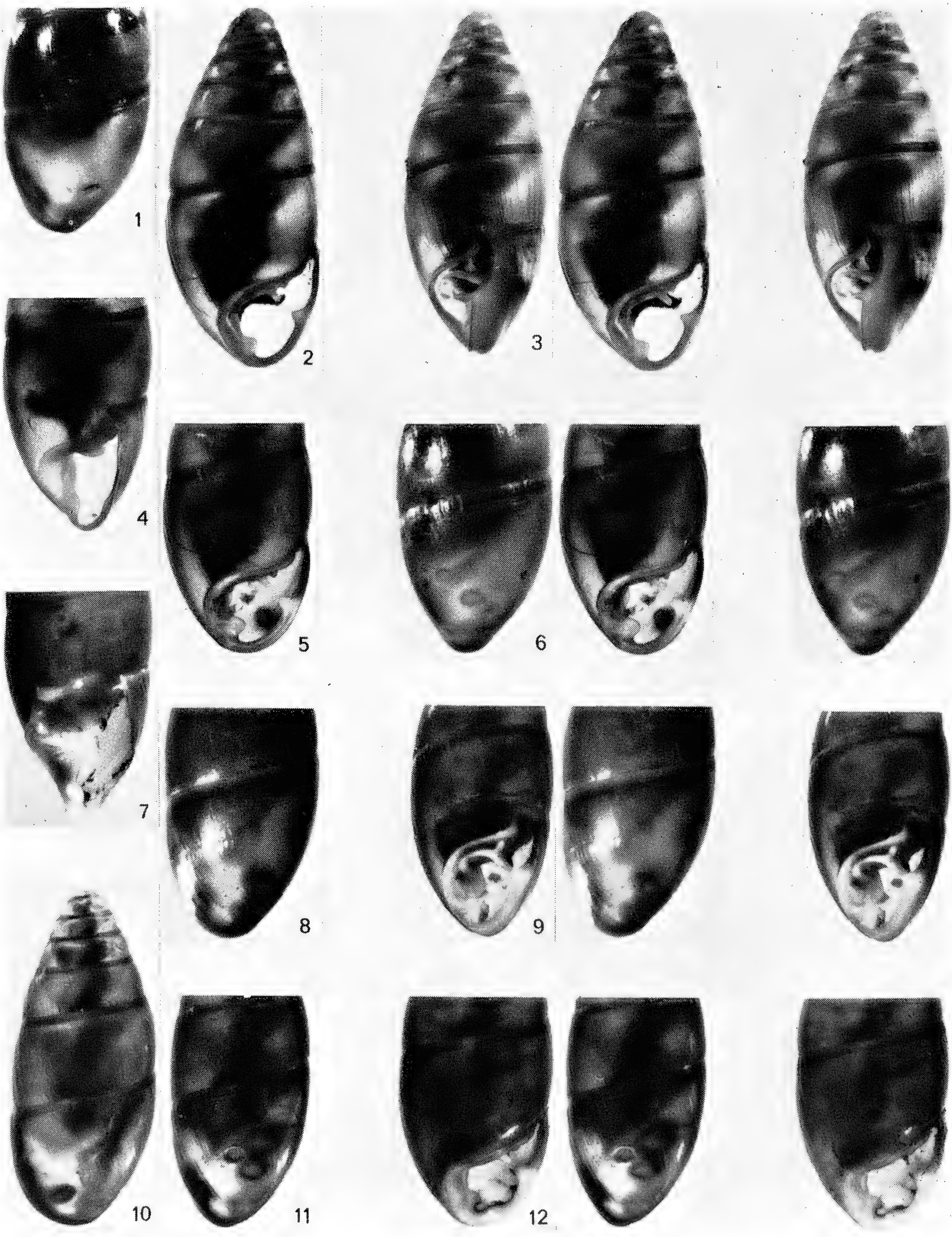

Plate VI

J. Conch. *28*: 173–178 (1974)

THE LAND OPERCULATE GENUS *POLLICARIA* GOULD (GASTROPODA), A SYSTEMATIC REVISION

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(*Read before the Society, 17th March 1973*)

The genus *Pollicaria* was established by Gould (1856 : 14) for a group of land operculates of the family Pupinidae characterised by a thick ovate shell, with the body-whorl distorted when adult and flattened in front, and with a circular aperture the internal callus of which is sinuate above and separated from the left margin of the peristome by a deep furrow. The operculum is a thick calcareous plate and the genus inhabits the area from Malaya and peninsular Burma eastwards to Tonkin in North Vietnam. The type of *Pollicaria, Cyclostoma pollex* Gould (Oct. 1856) had already been described in March of the same year as *Megalomastoma gravidum* Benson (1856 : 229) hence the latter name has priority. Subsequently Benson (1859 : 91) published the genus *Hybocystis* with *M. gravidum* as type. *Hybocystis* is thus a junior synonym of *Pollicaria* which must stand for the genus, with *P. gravida* (Benson) as type species.

The following species, referable to *Pollicaria*, have been described:

Megalomastoma gravidum Benson, March 1856
Cyclostoma (Pollicaria) pollex Gould, Oct. 1856
C. myersii Haines 1858
Hybocystis mouhoti Pfeiffer, 1862
H. elephas de Morgan, 1885
H. jousseaumi de Morgan, 1885
H. crossei Dautzenberg and d'Hammonville, 1887
H. rochebruni Mabille, 1887

Crosse (1885) first revised *Pollicaria.* He retained Benson's name *Hybocystis*, gave an account of the geographical distribution and catalogued the species under two sections. In section one he retained *H. elephas* de Morgan, with *H. jousseaumi* as a synonym. Section two contained *H. gravida* Benson (with a small form figured

EXPLANATION OF PLATE VI

Figs. 1, 3. *Pollicaria elephas* (de Morgan), Larout, Perak, Malaya.
Figs. 2, 5. *Pollicaria myersi* (Haines), Lao Mountains, Cambodia.
Figs. 4, 6. *Pollicaria gravida* (Benson), Than Moi, Tonkin, North Vietnam.
Fig. 7. *Pollicaria gravida* var. *minor* Crosse, Moulmein, Burma.
All figures x2. All original specimens in the author's collection.

by Pfeiffer, 1860, pl. 35, figs. 3–4) described as var. *minor, H. mouhoti* and *H. myersii*. This revision includes an excellent colour plate of *Hybocystis*.

After Crosse's paper appeared two further species were described, *H. crossei* Dautzenberg and d'Hammonville and *H. rochebruni* Mabille. Dautzenberg and Fischer (1905 : 171), discussing *H. gravida* Benson, state: "Il résulte de l'examen des nombreux matériaux rapportés du Tonkin par M. le C. Messager qu'il est impossible de séparer l'*Hybocystis rochebruni* Mab. = *crossei* D. et d'H. de l'*H. gravida* Benson, de la Birmanie Méridionale. Les caractères différentiels indiqués par M. Ancey (dernier tour beaucoup plus haut et ouverture beaucoup plus grand) ne présentent en effet aucune constance, et nous avons entre les formes extrêmes toute une série de passages insensibles." There is no doubt that this view is correct; *rochebruni* and *crossei* both being based upon large examples of *gravida*.

Solem pointed out (1966 : 13) that the parietal-palatal margin is evenly rounded in the *gravida* series, whereas it is angular in both *myersii* and *mouhoti*. Von Martens (1867 : 67) suggested that the latter two species were synonymous. Examination of a beautiful series of live-collected specimens from Muleak Jek, Saraburi, Thailand in the Melville-Tomlin collection (National Museum of Wales), shows a continuous graduation between typical *myersii* with a yellowish-white lip and typical *mouhoti* in which the lip is red-orange.

P. elephas (de Morgan) is much larger than either *P. gravida* or *P. myersii* and is the only species so far known from Malaya.

The genus *Pollicaria* is confined to mainland southeast Asia and is known from Burma, Thailand, Cambodia, Laos, North Vietnam and Malaya. *P. gravida* (Benson) is recorded from Burma and extends across the north of the area into N. Vietnam (Tonkin). *P. myersii* (Haines) occurs in Thailand, southwards into Cambodia and east into Laos. *P. elephas* (de Morgan) is confined to Malaya. Shells from Lao Kay, Tonkin, in the Field Museum of Natural History, Chicago, referred to *P. mouhoti* (Pfeiffer) by Solem (1966 : 13) extend the range of the *myersii* series northward but it is unlikely to be confused with the large form of *P. gravida* which also occurs at Tonkin.

Pollicaria spp. are not so far recorded as fossils. The small striated shells from the Upper Eocene of the south of France referred to *Hybocystis* by Filhol (1876 : 286) are certainly in no way related to *Pollicaria*.

Benson (1859) described the animal of *P. gravida* and Fischer (1895) both the animal and radula of *P. elephas*.

DESCRIPTIONS

Pollicaria gravida (Benson 1856) Plate VI, figs. 4, 6.

1856 *Megalomastoma gravida* Benson: 229.
1856 *Otopoma blennus* Benson: 231.
1856 *Cyclostoma (Pollicaria) pollex* Gould: 13.
1860 *Hybocystis gravida* (Benson), Pfeiffer: 123, pl. 35, figs. 1–4.
1866 *Pollicaria gravida* (Benson), Sowerby: pl. 263, fig. 5.
1870 *Megalomastoma gravidum* Benson, Hanley and Theobald: pl. 7, fig. 1.
1876 *Pollicaria gravida* (Benson), Reeve: pl. 8, fig. 68.
1885 *Hybocystis gravida* (Benson), Crosse: 187.
1885 *Hybocystis gravida* var. *minor* Crosse: 189, pl. 11, figs. 2, 2a

1887 *Hybocystis rochebruni* Mabille: 138, pl. 2, figs. 12–13.
1887 *Hybocystis crossei* Dautzenberg and d'Hammonville: 220, pl. 8, fig. 4.
1895 *Hybocystis gravida* (Benson), Cooke: 305 (fig. in text).
1905 *Hybocystis gravida* (Benson), Dautzenberg and Fischer: 171.
1921 *Pollicaria gravida* (Benson), Gude: 191, text-fig. 29.

Description. Shell solid, very ventricose, shortly pupaeform, fulvous, a little tortuous, apex obtuse; whorls 5, the three apical whorls short, rapidly increasing, the penultimate ventricose, gibbous on one side, the last large and oblique, narrow below, notched and umbilicated; aperture rounded, margin duplicated, outer margin raised above the suture, a little tabular, inner margin anteriorly extended beyond the outer; operculum a thick calcareous plate with 5 evenly increasing whorls, each whorl flanged and overlying the preceding one, nucleus central, exterior concave.

Distribution. Burma: Moulmein, Damotha (Stoliczka), Tovoy, Tenasserim (Crosse). North Vietnam: Than-Moi, Tonkin (Dautzenberg).

Discussion. P. gravida shows a distinct increase in size westwards. Burmese specimens are comparatively small; average length 32 mm, diameter 23 mm. The var. *minor* Crosse is only 24 mm long and 13½ mm in diameter. On the other hand specimens from Tonkin average 43 mm by 23 mm. *P. crossei* and *P. rochebruni* were based on large specimens from this area.

The external colour varies from pale flesh-colour through brown to dark reddish-purple. Burmese examples tend to be pale, those from Tonkin much darker. The surface is smooth but shows minute pitting under a lens. The aperture is circular with a thickened peristome and an obsolete channel visible at the top.

Immature shells are strikingly different before the distorted body whorl forms. They resemble perforate examples of *Pomatias* or *Otopoma* and such an immature shell served Benson for his type of *Otopoma blennus.* Three years after the publication of *O. blennus,* Benson obtained living examples of both this and *P. gravida* from the same locality. Examination of the animal left him in no doubt (Benson, 1859) that they represented juvenile and adult stages of the same species and showed that the shell of *O. blennus* corresponds to the spire of *P. gravida* before the latter develops its lengthened and distorted body whorl.

Pollicaria myersii (Haines 1858) Plate VI, figs. 2, 5.

1858 *Cyclostoma myersii* Haines: 157, pl. 5, figs. 9–11.
1862 *Hybocystis mouhoti* Pfeiffer: 227, 276, pl. 36, fig. 13, pl. 59. figs. 5–8.
1865 *Hybocystis mouhoti* Pfeiffer, Mouhot: 186, fig. 13.
1866 *Pollicaria myersii* Haines, Sowerby: pl. 263, fig. 9.
1867 *Hybocystis myersii* (Haines), von Martens: 67.
1876 *Pollicaria myersii* (Maines), Beere: pl. 8, fig. 69.
1885 *Hybocystis mouhoti* Pfeiffer, Crosse: 190, pl. 11, figs. 3, 3a–c.
1885 *Hybocystis myersii* (Haines), Crosse: 191, pl. 11, fig. 4.
1902 *Hybocystis myersii* (Haines), Kobelt: 290.
1966 *Pollicaria myersii* (Haines), Solem: 13.

Description. Shell moderately solid, pupaeform, ventricose, apex obtuse; whorls 5,

rapidly increasing, the last large elevated and narrowly umbilicate; aperture large, rather round, acuminate above, margin double, yellow white to orange; operculum as in *P. gravida.*

Distribution. Thailand (Haines): 20 km east of Wang Sapung, near Loei, North Thailand (Solem), Muleak Jek (Tomlin), Cambodia (Pfeiffer). North Vietnam: Loa Kay, Tonkin (Solem), Mungo Bo (Tomlin).

Discussion. In both *P. myersii* and the synonymous *P. mouhoti* the margin of the peristome is angular, not rounded as in *P. gravida.* Furthermore the lip is flared backwards and distinctly rimate whereas it is solidly thickened in *P. gravida.* The surface of the body-whorl is minutely pitted as in *P. gravida* but in one example from Cambodia it is distinctly malleated. This latter sculpture is not developed in any of the numerous examples from Thailand. A typical adult shell from Thailand measures 38 mm long by 19½ mm in diameter and one from Cambodia 41 mm by 20 mm. Von Martens (1867:67) suggested that these two species might be synonymous and examination of a considerable series of adult examples leaves me in no doubt about this.

Pollicaria elephas (de Morgan 1885) Plate VI, figs. 1, 3.

1885 *Hybocystis elephas* de Morgan: 404, pl. 7, figs. 1a–i.
1885 *Hybocystis jousseaumi* de Morgan: 405, pl. 7, figs. 2a–f.
1885 *Hybocystis elephas* de Morgan, Crosse: 183, pl. 11, fig. 1, 1a–e.
1885 *Hybocystis jousseaumi* de Morgan, Crosse: 184.

Description. Shell very strong and solid, pupaeform, very pale brown, somewhat tortuous, apex obtuse; whorls 5½, the apical short, then rapidly increasing, the penultimate ventricose, gibbous on one side and oblique, narrowing below; umbilicus narrow but deep; suture margined and puckered; aperture rounded, margin continuous, duplicated, the peristome greatly thickened and extended anteriorly. Apical whorls smooth, body-whorl often strongly pitted. Operculum as in *P. gravida.*

Distribution. Malaya: Perak Province, Larout, Kinta and Pluss Valleys (de Morgan).

Discussion. This magnificent species is known only from Malaya and is apparently endemic. It is very much larger than either *P. gravida* or *P. myersi.* An adult example from Larout measures 51 mm by 25½ mm. The external colour varies from white to orange. The aperture is rounded as in *P. gravida,* the peristome thickened and reflected and up to 5 mm across at the rim. The obsolete channel at the top of the aperture is present in this and both other species. *P. jousseaumi* was based on a small example with somewhat shouldered whorls, length 44 mm diameter 22 mm.

SUMMARY

Revision of the genus *Pollicaria* Gould 1865 has resulted in the acceptance of three valid species with the following characters and distribution:—

P. gravida (Benson). Type species. Shell very ventricose, short, pupaeform, peristome margin rounded, lip solidly thickened, body-whorl minutely pitted. Burma to North Vietnam.

P. myersi (Haines). Shell pupaeform, moderately solid, peristome margin angular, lip flared backwards and distinctly rimate, body-whorl pitted and rarely malleated. Thailand and Cambodia.

P. elephas (de Morgan). Shell large, very strong and solid, pupaeform, the penultimate whorl ventricose and gibbous on one side, aperture rounded, peristome greatly thickened and extended anteriorly, body-whorl strongly pitted. Malaya (endemic).

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PTEROPODS OF SCOTTISH AND ADJACENT WATERS

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(Read before the Society, 17th March 1973)

For some years the Marine Laboratory, Aberdeen has carried out investigations into the plankton around the Scottish coast and in the north east Atlantic from latitude 55°N north to the south coast of Iceland and west to longitude 20°W (Fig. 1). In this paper brief descriptions of the pteropod species collected during the investigations and their distribution are given.

In these investigations two main sampling gears were used; conical nets of one metre diameter with 26 to 60 meshes to the inch, and high speed Gulf III samplers with mouth apertures of approximately 20 centimetres (Fig. 2). The metre nets and Gulf III samplers were normally operated as oblique hauls from 250 m depth or bottom, although occasionally hauls were made from greater depths. The one metre nets were towed at $1\frac{1}{2}$ to 2 knots and the Gulf III was towed at 6 knots.

The one metre net with its larger mouth aperture is more successful in obtaining individuals of the scarcer species but the Gulf III high speed sampler is very useful for quantitative sampling of high density species.

DESCRIPTION OF SPECIES

The following descriptions are of the species collected during these investigations and detail the characters used in their identification.

Order Thecosomata: shelled pelagic opisthobranchs (Van der Spoel, 1972).

Genus Peraclis Forbes

P. triacantha (Fischer) Shell transparent, depressed, broader than high. Sculpture of fine lines of punctae, especially longitudinally. Rostrum short with very broad columellar membrane on free part. Aperture large, with two processes (excluding rostrum) strengthened by short ribs. Height 3 mm, breadth 5 mm.

P. moluccensis (Tesch) Shell transparent, depressed, height little more than breadth. Sculpture of growth lines only. Rostrum long with narrow columellar membrane. Aperture large with a very large spine protruding near suture. Height 3 mm, breadth 2–5 mm.

Genus Limacina Bosc, given priority over *Spiratella* Blainville, by Van der Spoel (1972).

L. helicina (Phipps) Shell transparent, depressed, broader than high. Sculpture of distinct vertical lines on all whorls. Umbilicus very wide, accentuated by a raised

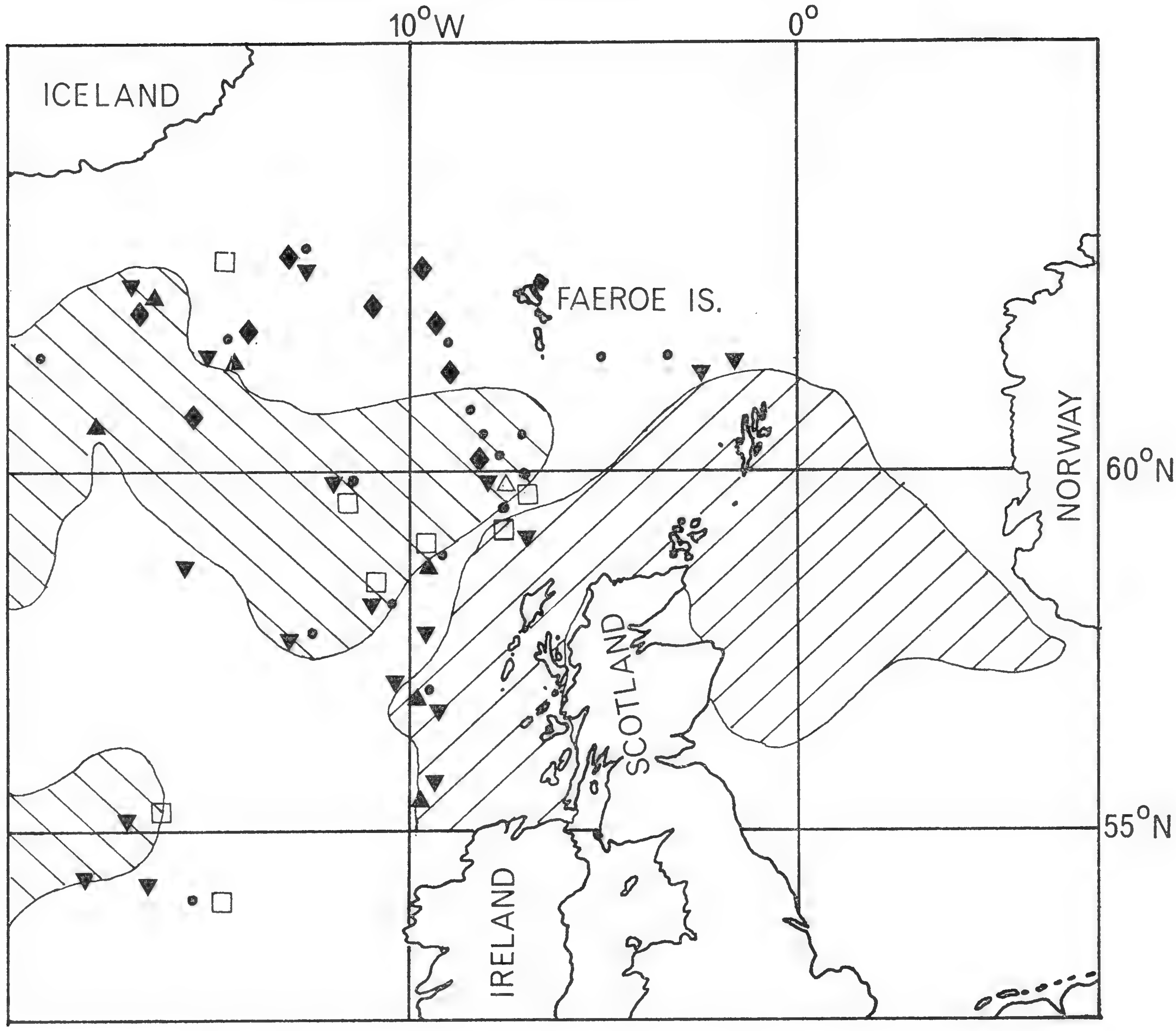


Fig. 1. North-east Atlantic showing incidence of pteropod species.

Common shelf species: *Limacina retroversa*, *Clione limacina*, *Pneumodermopis paucidens*	△ *Peraclis moluccensis*
	▲ *Limacina helicoides*
	● *Clio cuspidata*
	□ *Clio polita*
	▼ *Diacria trispinosa*
Clio pyramidata	♦ *Pneumodermopsis ciliata*

ridge around it. Maximum dimensions; height 6 mm, breadth 8 mm but generally much smaller.

L. retroversa (Fleming) (Fig. 3a). Shell transparent, turreted, higher than broad, sculpture of very fine longitudinal and vertical striations with a small, but distinct umbilicus. Height 7 mm, breadth 2·4 mm but often much smaller in the North Sea.

L. helicoides (Jeffreys) Shell chesnut coloured, of 3 rapidly increasing whorls shaped like *Helix*, broader than high. Umbilicus very small. Sculpture of fine longitudinal lines of punctae, often interrupted. Height 11 mm, breadth 15 mm.

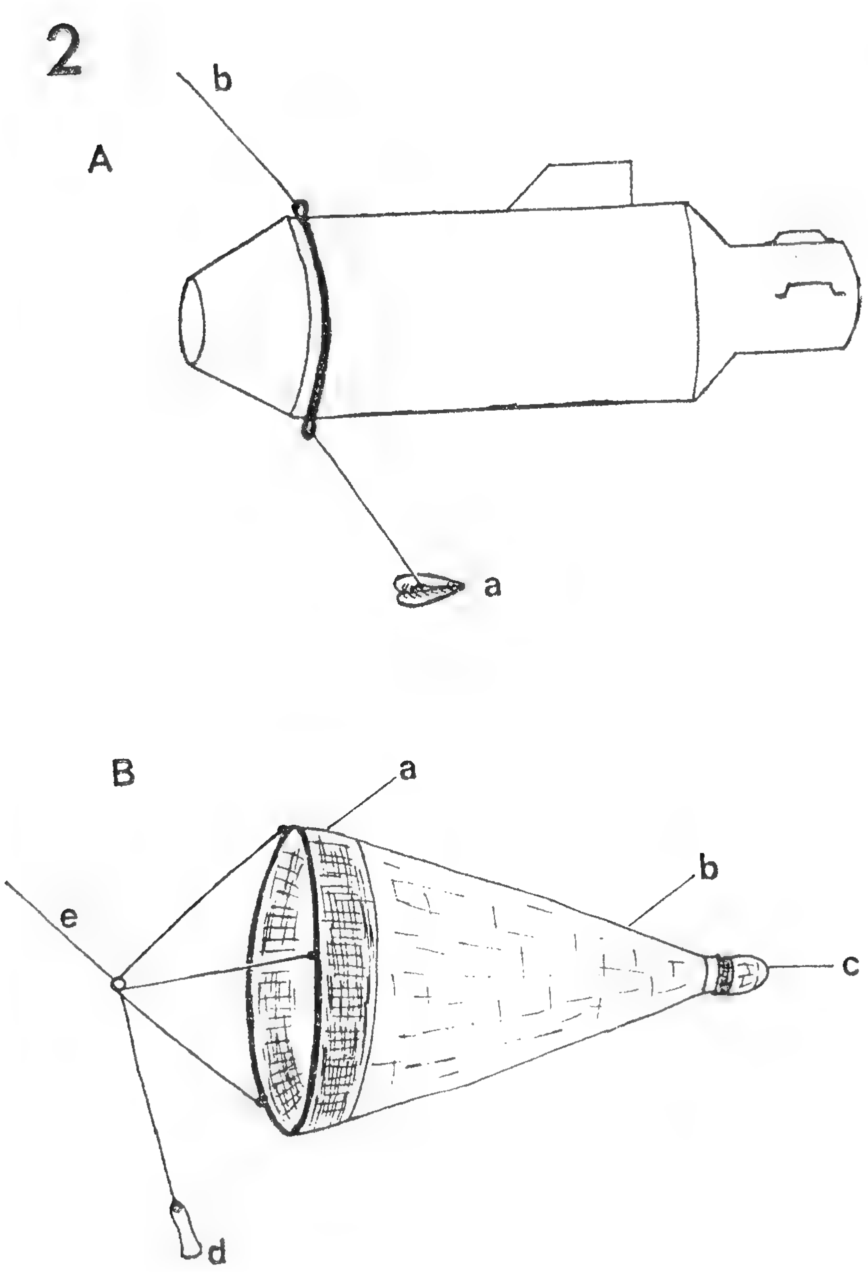
Genus Clio Linnaeus—given priority over *Euclio* Bonnevie by Van der Spoel (1972).

C. pyramidata (Linnaeus) (Fig. 3b) Shell hyaline, quite straight, not curved dor-

sally, forming a high triangle when viewed from above: ending in a conical embryonic shell. Sculpture of 3 dorsal ribs, the middle one very strong, projecting beyond the widely gaping aperture, in transverse section forming a low triangle. Height 20 mm, breadth 10 mm.

C. cuspidata (Bosc) (Fig. 3c) Shell hyaline, with posterior part gradually curved dorsally, ending in a conical embryonic shell, with a narrow median rib projecting beyond the extremely wide aperture with the lateral edges drawn out into long spines, sticking out sideways. Height 20 mm, breadth 30 mm (including spines).

C. polita (Pelseneer) Shell greyish, slender with posterior part evenly curved dorsally, ending in a globular embryonic shell. Sculpture only of very faint growth lines. Aperture not widely gaping, lateral edges sharp and continuous to the embryonic shell. Height 14 mm, breadth 7 mm.



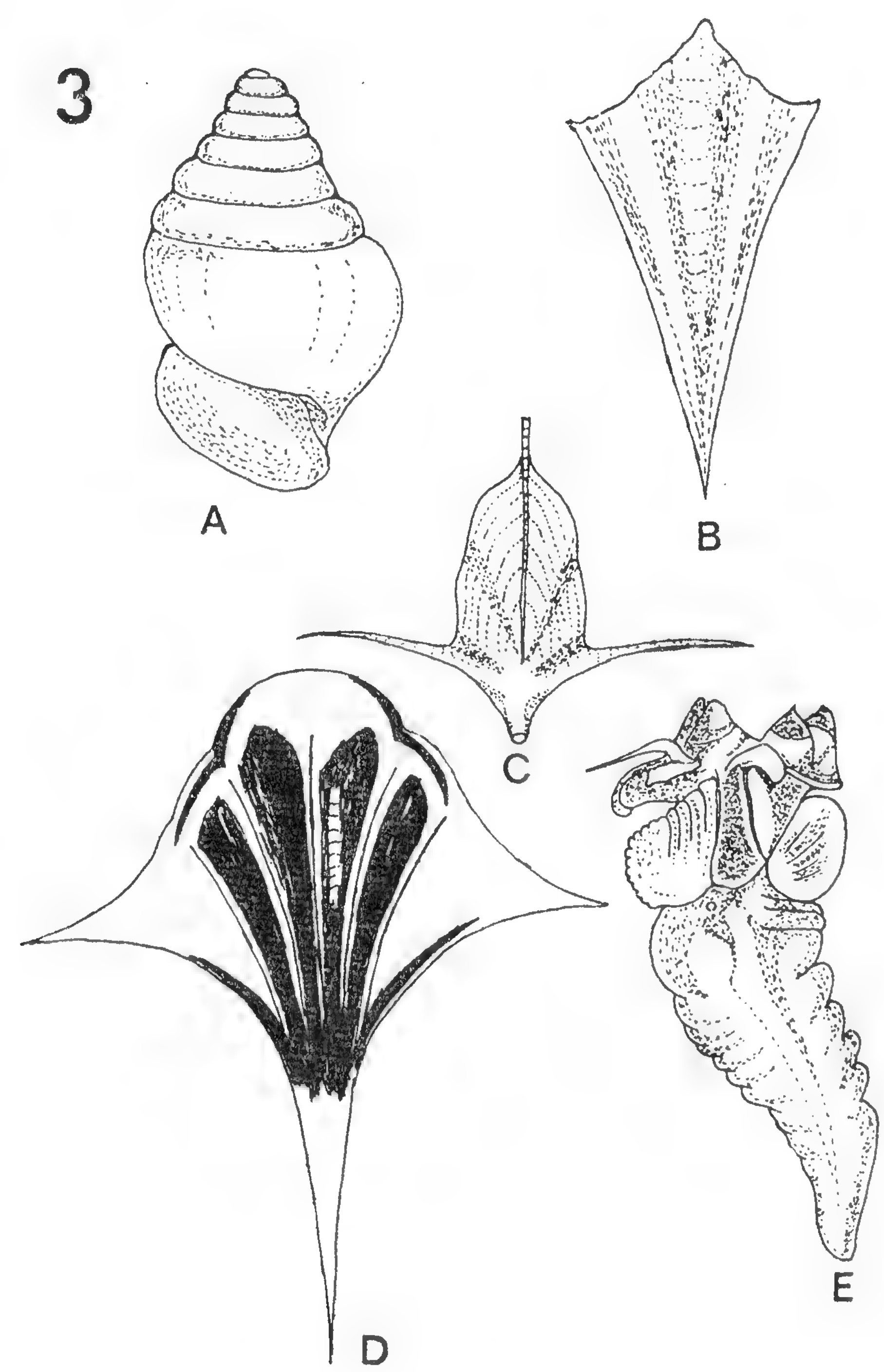


Fig. 2. Plankton sampling gear A Gulf III high speed sampler a. Depressor b. warp to boat B One metre net a. Canvas webbing b. Fine mesh silk or nylon c. Codend or bucket which retains catch in good condition d. Weight e. Warp to boat.

Fig. 3. Some common pteropods. A. *Limacina retroversa* ×30. B. *Clio pyramidata* ×6. C. *Clio cuspidata* ×3. D. *Diacria trispinosa* ×8. E. *Clione limacina* ×6.

Genus Diacria Gray

D. trispinosa (Blainville) (Fig. 3d) Shell chesnut-brown rhomboidal in outline but drawn into lateral processes and a straight hind stalk. Maximum width behind

aperture which is a slit with thickened dorsal and ventral edges. Height 12 mm, breadth 11 mm.

Order Gymnosomata: Shell-less pelagic opisthobranchs with a fusiform or cylindrical body, tapered or rounded behind. Small ventral foot produced into flap-like parapodia or swimming wings. External gills posterior and/or on the right side, or lacking. Complex buccal armature consisting of a pair of reversible hook sacs and either adhesive conical tentacles (cephaloconi) or branched tentacles bearing suckers (Morton, 1957a, b).

Genus Pneumodermopis Keferstein. Body narrowed but not sharply tapered behind. A median arm with terminal and large lateral suckers on the side arms. Right lateral gill a triangular flap, with no posterior gill. Hook sacs with minute hooks.

Three species have been found in Scottish and adjacent waters:
P. paucidens (Boas) Length 5 mm but usually less.
P. ciliata (Gegenbaur) Length 5 mm.
P. michaelsarsi (Bonnevie) Length 5 mm.

These species are rather similar but *P. paucidens* and *P. ciliata* can be identified using the arrangement of suckers (Morton, 1957a) and the number of hooks in the hooks-sacs (Cooper and Forsyth, 1963) and *P. ciliata* and *P. michaelsarsi* can be separated using the configuration of the radular teeth (Van der Spoel, 1964).

Genus Clione Pallas

C. limacina (Phipps) (Fig. 3e) Body prolonged behind into a short tapered 'tail', head separated by a distinct neck, median lobe of foot is triangular. Buccal armature of 3 pairs of more or less smooth buccal cones with long cylindrical hooks of different lengths, all reaching to the opening of the hook-sacs—Morton (1957b).

DISTRIBUTION AND ABUNDANCE

The level of abundance of the various species of pteropods in the area covered in this investigation is given in Table 1. The centre of distribution of pteropods in Scottish waters is in the north-east Atlantic (Fig. 1) although *Limacina retroversa* reaches its maximum densities on the continental shelf where oceanic influence is marked and where as much as one litre of *L. retroversa* has been taken in a 15 minute haul with a one metre net.

TABLE 1

Incidence of Pteropods in Plankton samples from Scottish waters

ABUNDANT	COMMON	SCARCE	RARE
Limacina retroversa	*Clione limacina*	*Diacria trispinosa*	*Peraclis moluccensis*
	Clio pyramidata	*Clio cuspidata*	*Peraclis triacantha*
	Pneumodermopsis paucidens	*Pneumodermopsis ciliata*	*Limacina helicina*
		Pneumodermopsis michaelsarsi	*Limacina helicoides*
			Clio polita

TABLE 2

Frequency of Occurrence of Pteropods in the mixed water of the Scottish Shelf.

Occurring in years of very little oceanic influence	Occurring in years of higher than normal influx	Occurring only in years of very high influx
Clione limacina	*Clio pyramidata*	*Diacria trispinosa*
Pneumodermopsis paucidens	*Clio cuspidata*	*Limacina helicoides*
	Pneumodermopsis ciliata	*Limacina helicina*

Pteropods other than *Limacina retroversa* do however invade the continental shelf area with influxes of oceanic water and form good indicator species for mixed oceanic and inshore water on the continental shelf. The frequency of invasion of pteropods into the continental shelf area is given in Table II. Pteropods however are very rarely collected in inshore water.

In Table I some of the species listed as rare are bathypelagic in distribution, i.e. they are normally collected from depths greater than 800 m, and their apparent rarity may be due to the small number of hauls to depths of over 1000 m made during the Scottish investigations. More detailed information on the distribution of pteropods in the north-east Atlantic can be found in Fraser (1961), Vane and Colebrook (1962), Cooper and Forsyth (1963) and Van der Spoel (1964).

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DAYTIME RESTING SITES OF *AGRIOLIMAX RETICULATUS* (MÜLLER) AND *ARION INTERMEDIUS* NORMAND ON GRASSLAND

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(*Read before the Society 14 April 1973*)

The grey field slug, *Agriolimax reticulatus* (Müller) has been shown to have daytime resting sites in woodland associated with the presence of ground flora as opposed to bare earth (Pallant, 1969b) although in quadrat studies of ground flora there was no apparent association between resting sites and favoured food plants (Pallant, 1967). South (1965) however found distribution of this species to be associated with tufts of *Dactylis glomerata* L. on pasture in which this was the dominant grass (c. 40%).

Three surveys were carried out related to this topic. The first was a series of forty three 1000 cm^2 quadrat studies of a hayfield at Beverley Grammar School, Yorks (Nat. Grid Ref. 54/029388). This was designed to show if *A. reticulatus* was aggregated in association with *Ranunculus repens* L. which had been shown to be a favoured food source of this slug in woodland (Pallant, 1969a). Of 21 quadrats in which the only herbs were grasses, 8 contained slugs and 13 were without. Of 22 quadrats containing *R. repens* in addition to grasses, 5 contained slugs and 17 had no slugs. These data show no significant association between *A. reticulatus* and either type of quadrat (χ^2, 1·2; $P > 0{\cdot}1$). Other groups of animals, mostly arthropods, were evenly distributed between the two types of quadrat also. This survey was made by Sixth Form biology pupils on a sunny afternoon in June. The vegetation retained free water (dew) but the soil surface over most of the field was dry.

The other surveys were made on rough common pasture, Beverley Westwood, Beverley, Yorks (Nat. Grid Ref. 54/026387). This is an area of semi-natural grassland grazed by sheep and cattle for most of the year and the particular region sampled has been described in more detail elsewhere (Pallant, 1972). The dominant grass is *Holcus lanatus* L. (C. 40%) and tussocks of *Deschampsia caespitosa* (L.) Beauv., which are not browsed by the animals, form a discontinuity in the otherwise closely cropped sward. The first survey on this grassland investigated distribution of slugs as between the *D. caespitosa* tussocks and the grazed sward and was again made on sunny days in June. The sample unit in this case was a handful of grass torn up from the sward and the ground exposed by removing the grass. 51 *D. caespitosa* samples and 49 of grazed sward were examined in this way. The ground area exposed in each case was approximately 50 cm^2 and compressed

volumes of grass removed were 500 cm³ in the case of *D. caespitosa* and 50 cm³ in the case of the grazed sward. It is however suggested that equivalent volumes of shelter were compared since slugs were always found in the lowest few centimeters of the grass. Samples were taken in the late morning or early afternoon; there had been no rain for at least three days, and as in the previous survey the soil surface was mostly dry but free moisture remained on the grasses towards the base of tufts. In a number of samples the temperature within the sward was measured with a secondary standard mercury in glass thermometer before plucking the grass and the relative humidity was measured immediately after plucking by placing a hair hygrometer on the ground under the replaced tuft.

TABLE 1

Beverley Westwood *D. caespitosa*/cropped sward survey.

Date and time of sampling	Numbers of samples							
	D. caespitosa tussocks				Cropped Sward			
	With *A. reticulatus*	Without *A. reticulatus*	With *A. intermedius*	Without *A. intermedius*	With *A. reticulatus*	Without *A. reticulatus*	With *A. intermedius*	Without *A. intermedius*
10 June 1969 11 a.m. – 12 noon	6	24	17	13	0	30	8	22
10 June 1969 2 – 4 p.m.	2	8	2	8	0	8	0	8
11 June 1969 12 noon – 12.30	3	0	1	2	0	3	0	3
12 June 1969 2.50 – 3.30 p.m.	3	2	1	4	0	5	0	5
16 June 1969 3.10 – 3.35 p.m.	1	2	3	0	0	3	2	1
Totals:	15	36	24	27	0	49	10	39

A. reticulatus and *Arion intermedius* Normand were the only species of slug found in this survey. The presence or absence of these two species in the samples is indicated in table 1. There is an association between the distribution of slugs and the *D. caespitosa* tussocks as indicated by a chi-square analysis of the totals in table 1 (χ^2, 39·8; $P < 0{\cdot}01$). The data for the two species of slug were also tested separately and for both there is an indication of this association although since no *A. reticulatus* were found in the cropped sward at these times the association is closer for this species (*A. reticulatus*: χ^2, 16·97; $P < 0{\cdot}001$. *A intermedius*: χ^2, 7·91; $P < 0{\cdot}01$). In the cases of all samples after those of the first row of table 1 the temperature and relative humidity measurements described above were taken. These data are listed with vapour pressure deficits calculated from them and with numbers of slugs found for each sample in table 2. It will be seen that the temperatures tended to be lower in the *D. caespitosa* tussocks although the relative humidity tended to be higher in the cropped sward tufts. However whilst the difference in the main temperature of the two kinds of sample is significant (t, 3·97; $P < 0{\cdot}001$), the difference between the mean vapour pressure

TABLE 2

Temperature, Relative Humidity, Vapour pressure deficit and numbers of slugs in samples from *D. caespitosa* tussocks and cropped sward tufts, Beverley Westwood, Yorks.

SAMPLING DATE (1969)	*D. CAESPITOSA*			NUMBER OF SLUGS		CROPPED SWARD			NUMBER OF SLUGS	
	Temperature	Relative humidity	Vapour press. deficit	*A. reticulatus*	*A. intermedius*	Temperature	Relative humidity	Vapour press. deficit	*A. reticulatus*	*A. intermedius*
	(°C)	(%)				(°C)	(%)			
10 June	17	75	3·6	0	0	21	77·5	4·2	0	0
	17	78	3·2	1	1	19	80	3·3	0	0
	17	80	2·9	1	0	23	65	7·3	0	0
	19	70	4·9	0	0	22	70	5·9	0	0
	17	76	3·5	3	0	26	77·5	5·7	0	0
	16	85	2·0	1	0	16	(90)	1·3	0	0
	17	(85)	2·2	0	2	17·5	(90)	1·5	0	2
	16	(85)	2·0	0	1	17	90	1·4	0	1
	15	80	2·6	2	1					
	16	82·5	2·4	1	0					
11 June	15	80	2·6	3	0	20	82·5	3·1	0	0
	16	72·5	3·7	0	0	24	85	3·3	0	0
	16	72·5	3·7	0	0	21	80	3·7	0	0
12 June	14·5	77·5	2·8	0	0	18	77·5	3·5	0	0
	14·5	80	2·5	0	1	18·25	80	3·1	0	0
	14·5	72·5	3·4	0	0	16·5	77·5	3·2	0	0
	14	80	2·4	0	1	16	75	3·4	0	0
	14	72·5	3·4	0	0	21	72·5	5·1	0	0
16 June	13	75	2·8	1	0	18·5	70	4·8	0	0
	15	80	2·6	0	0	17	70	4·3	0	0
	14	75	3·0	2	0	18	70	4·6	0	0
Overall means	15·6	76·5	2·9	0·71	0·33	19·4	74·7	3·8	0	0·16

deficit is not (t, 2·28; P > 0·1). Carthy (1958) suggested that slugs might be able to detect loss of water through the resulting change in concentration of body fluids since Kerkut and Taylor (1956) had reported that the pedal ganglion was sensitive to osmotic changes. It is perhaps just possible therefore that a slug could follow a vapour pressure deficit gradient to a resting site where water loss would be minimised. It seems likely however that this would be a minor orientating device within the microhabitat of the resting site in the present case. Dainton (1943, 1953) has shown that *A. reticulatus* responds to changes in temperature, light and air currents and Duval (1972) has shown movement towards shade from light. These reactions could provide an explanation of the above results considering that the initially resting sites would be sought in early morning although conditions later in the day could effect a subsequent readjustment. The dense *D. caespitosa* tussocks would provide adequate shelter from some predators and

TABLE 3

Numbers of slugs found in Beverley Westwood quadrats, 1969.

DATE	MARCH												MAY						JUNE	
	3						4		6				22			23			3	
Quadrat Ref.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
A. reticulatus adults	1	2	–	–	–	3	3	1	1	–	–	–	–	2	–	–	1	–	–	–
A. reticulatus eggs (batches)	1	2	1	1	–	2	1	–	1	–	–	–	–	–	1	–	–	–	–	–
A. intermedius	1	3	–	1	–	–	–	–	–	–	–	–	2	–	1	–	4	–	–	–
A. fasciatus	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–	–	–
D. caespitosa present		x				x					x		x							

(Mean number of *A. reticulatus* eggs per batch, 4·25)

from casual damage by browsing sheep and cows whilst also providing a possible source of food for *A. reticulatus* (Pallant, 1972).

The second survey of Beverley Westwood consisted of an investigation of 20 quadrats each approximately 1000 cm^2 in area. A wire square of 31·6 cm side was thrown at random within the general area of approximately 0·125 km^2 which was under investigation. The grasses within the square, torn up by hand, and the surface soil layers were searched for slugs and eggs immediately and spread on a sheet of off-white paper. The grasses were packed in polythene bags and hand sorted once again on white enamelled trays in the laboratory. Twelve quadrats were examined in the late morning in March, 1969, six were examined at similar times in late May and two more were examined in early afternoon in June. The numbers of slugs and batches of eggs found in these quadrats are listed in table 3. Quadrats 9–12 inclusive were taken while there was hoar frost on the ground and vegetation. At other times the ground and vegetation was moist after light rain. In addition to the two species of slug found in the tuft survey one specimen of *Arion fasciatus* (Nilsson) was found in May.

Most of these quadrat samples were from the cropped sward inevitably since the *D. caespitosa* tussocks occupied only approximately 4·3% of the area; however three of the March samples were from these tussocks, and one of the May samples included the edge of a tussock. Again both *A. reticulatus* and *A. intermedius* were significantly associated with the presence of *D. caespitosa* in these quadrats, and likewise the egg batches of *A. reticulatus*.

POPULATION ESTIMATES

It is possible to make rough estimates of populations from the two Beverley Westwood surveys. These are likely to be minimal estimates if it is assumed that resting sites in the soil are also available to the animals and used by them when the observations were made. The estimates are perhaps limited in accuracy by

the small number of samples on which they are based. However for the species *A. reticulatus* the estimates are reasonably close to that found by South (1965) in a quadrat study of recently grazed pasture in Northumberland, 10·76 per m², although on pasture which had not been recently grazed 60·28 per m² were found.

There is a significant increase in the average live weight of the *A. intermedius* samples from 12·35 mg in March to 50·43 mg in May (t, 3·837; $P < 0{\cdot}01$); The difference between the mean live weights of *A. reticulatus* in March and May samples is not significant (t, 0·0075; $P > 0{\cdot}1$) although at least five of the March sample had live weights less than 100 mg and the three animals in the May samples were all over 150 mg.

TABLE 4

Population estimates from Beverley Westwood tuft samples and quadrats.

SPECIES	ESTIMATED NUMBERS PER M² QUADRATS MARCH	MAY/JUNE	TUFTS JUNE
A. reticulatus adults	9·16	3·75	6·1
A. reticulatus eggs	32·14	5·00	–
A. intermedius adults	4·17	8·75	32·8

TABLE 5

Estimates of biomass for *A. reticulatus* and *A. intermedius* on rough grassland, Beverley Westwood, 1969, per m².

SPECIES	UNITS	MARCH	MAY/JUNE
A. reticulatus	Live weight (mg)	1311·44	745·12
,,	Vacuum dry weight (mg)	159·34	91·62
,,	Energy (calories)	806·26	463·26
A. intermedius	Live weight (mg)	51·50	441·26

Biomass estimates derived from the population estimates of table 4 are given in table 5 as live weights, dry weights and energy values. Other species of slugs have been shown to contain very variable amounts of water (Howes and Wells, 1934) and the condition of the *A. reticulatus* used to determine wet to dry weight ratios may not be comparable. This factor would also affect the energy values given in the table. However the slugs used in these determinations (Pallant, 1973) had been previously maintained in water saturated conditions which are likely to have persisted in the field before collection and in the conditions in which

they were kept before live weights were determined. The periodic fluctuations in weight referred to by Howes and Wells would at worst be minimised in these conditions and at best could be neutralised by variations in the different individuals being out of phase. The energy values are also approximate in that they assume that the energy value per milligram dry weight of animal body is similar to that of the animals on which the energy determinations were made. However they are published as the best estimates at present available.

SUMMARY

Three surveys were made of resting sites of slugs on grassland. In a hayfield in June *Agriolimax reticulatus* was found by a quadrat survey not to be associated in distribution with *Ranunculus repens*.

In a survey of hand plucked tufts on rough pasture in June *Agriolimax reticulatus*, eggs of this species and *Arion intermedius* were found to be associated with *Deschampsia caespitosa* tussocks as opposed to the cropped sward of other grasses. Temperature was found to be lower in the *D. caespitosa* tussocks than in the cropped sward. It is suggested that the *D. caespitosa* tussocks would provide protection from casual damage by the grazing animals.

A quadrat survey of the same area of rough pasture in March and May also showed association in distribution between *A. reticulatus, A. intermedius* and *D. caespitosa* tussocks.

Population and biomass estimates were deduced from the data of the rough pasture surveys.

ACKNOWLEDGEMENTS

I am grateful to the biologists of the Lower Sixth Form at Beverley Grammar School, Yorks, 1968–9 for the hay field quadrat data. I would also like to thank The Royal Society Committee for Scientific Research in Schools for their support of slug research at Beverley Grammar School and at Brune Park School and to thank my adviser Professor Mark Williamson.

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THE CONCHOLOGICAL SOCIETY OF GREAT BRITAIN AND IRELAND

INCOME AND EXPENDITURE ACCOUNT FOR THE YEAR ENDED 31st DECEMBER, 1972

	£	£	£
Publications:			
News Letter			514·08
Student Papers			98·23
Journal:			
Volume 26 – Title Page		31·83	
Volume 27 No. 4			
O/P copies bought in ...		45·25	
Volume 27 No. 5/6 ...	1,363·64		
Authors Reprints ...	78·77		
		1,284·87	
			1,361·95
Expenses of Meetings ...			19·00
Transfer Charges ...			1·75
Bank Charges			2·80
Printing, Stationery and Postage			338·60
Officers' Expenses ...			161·74
Subscriptions			7·00
			2,505·15
Net Surplus			692·70
			£3,197·85

	£	£
Fees and Subscriptions		
Membership Fees	1,476·53	
Subscribers	731·19	
Entrance Fees ...	26·00	
		2,233·72
Donations – General	35·05	
Legacy (Mr. C. P. Castell)	500·00	
		535·05
Sales:		
Advertising ...	39·75	
Journal	21·10	
Student Papers	29·38	
News Letter	13·96	
		104·19
Investment Income:		
General Account	276·72	
Life Members' Fund ...	48·17	
Reserve and Research Fund ...	70·28	
	395·17	
Transfer to Reserve and Research Fund	70·28	
		324·89
		£3,197·85

BALANCE SHEET AS AT 31st DECEMBER, 1972

	£	£
Fees and Subscriptions in Advance		323·55
Life Membership Fund		850·00
Reserve and Research Fund ...		1,310·02
Capital Account		
Balance Bt./Fwd.	4,883·16	
Add Surplus	692·70	
		5,575·86
		£8,059·43

	£	£
Cash at Bank: Current Account ...	732·00	
Deposit Account ...	2,956·24	
Cash in Hand	1·29	
		3,689·55
Investments		
£400 5% Treasury Stock 1986/89 (£267·00)	344·00	
£500 $5\frac{3}{4}$% Deb. Stock Mersey Docks and Harbour Board 1976/78	460·85	
£737 13s. 5d. $6\frac{3}{4}$% Stock Greater London Council (£678·00) ...	721·52	
2,514 Units M. & G. Dividend Fund (£2,365·00)	1,522·06	
£400 $5\frac{3}{8}$% Loan City of Norwich	400·00	
£800 $5\frac{1}{2}$% Loan London County Council	769·20	
420 Scotbor Income Units (£241·00)	152·25	
		4,369·88
		£8,059·43

Wm. F. Edwards
Charles Pettitt } Hon. Auditors.

1.2.1973

Marjorie Fogan,
Hon. Treasurer.

J. Conch. 28: 195–201 (1974)

PROCEEDINGS OF THE CONCHOLOGICAL SOCIETY OF GREAT BRITAIN AND IRELAND

878th (ORDINARY) MEETING, 18 MARCH 1972

Communications. "Marine Mollusca from Bahrain" by Mrs. K. Smythe. "Marine Mollusca collected by the British Dahlak Quest Expedition" by Rev. H. E. J. Biggs. "*Lauria sempronii* (Charpentier) living in Britain" by M. P. Kerney and A. Norris. "Studies on variation and life history in the prosobranch *Hydrobia ulvae* (Pennant)" by J. E. Chatfield. "*Discus rotundatus* (Muller) growing on algae" by J. E. Chatfield and B. W. Barrett.

Lecture. "Conservation and the Countryman" by the Rt. Hon. the Earl of Cranbrook, C.B.E.

Elections

Mrs. K. Barker, West Green, Barrington, Cambs.
Miss M. L. Holloway, Nat. Dip. Art & Design, British Museum (Natural History), Cromwell Rd., S. Kensington, SW7.

879th (ORDINARY) MEETING, 15 APRIL 1972

Communications. "Relationship of size to age in the cockles *C. edule* and *C. glaucum* from the River Crouch estuary, Essex" by C. R. Boyden. "Do-it-yourself larval torsion simulators for teachers" by P. E. P. Norton. "Some Mollusca from Bornu Province, northern Nigeria" by T. E. Crowley, J. R. Green and N. F. McMillan.

Lecture. "Through the Everglades in a pair of carpet slippers" by S. P. Dance.

Elections

Dr. W. Backhuys, Maredijk 75, Leiden, Holland.
M. E. Christie, 3 Woodlands View, West Looe, Cornwall.
P. B. Edgely, B. A., 57 Blackbrook Lane, Bickley, Kent.
R. A. P. Goddon. 1 Mon Crescent, Bitterne, Southampton.
Miss J. Robson, Y.W.C.A., 123 Prince's Ave., Hull, E. Yorks.
Rijksuniversitet-Gent, Geologisch Institut, Bibliotheek en Museum Rozier 44, B-9000 Gent, Belgium.
J. R. Watkin, B. Ed., 45 Wakefield Rd., Tandem, Huddersfield, Yorks.

Members Deceased

I. Akerblom, C. P. Castell

880th (ORDINARY) MEETING, 21 OCTOBER 1972

Communications. "The names *Partulida* Schaufuss and *Spiralinella* Chaster (Gastropoda: Pyramidellacea)" by James X. Corgan. "The acceptability of various weed species as food for *Arion hortensis* Férussac" by D. Duval. "*Lauria cylindracea* and *Granopupa granum*, two species of terrestrial molluscs to be removed from the South African list" by A. C. van Bruggen. "A note on the Hudi Chert freshwater Mollusca with a description of *Lanistes grabhami* Cox 1933" by A. Gautier. "A preliminary report on a keeled brackish water gastropod from Morocco" by D. van Damme. "Associations of molluscs and marine plants at San Diego, California" by M. J. Bishop

and S. J. Bishop. "Molluscan survey of Ham Street Woods N.N.R., Sussex" by F. Berry. "The occurrence of *Charonia lampas* (L.) at Guernsey" by R. N. Brehaut.

Lecture. "Hairy snails" by Dr. J. E. Chatfield.

Members Deceased

Mrs. H. P. V. Bailey, A. W. Stelfox.

881st (ORDINARY) MEETING, 18 NOVEMBER 1972

Communications. "Two new species of Marginellidae from West Africa" by P. W. Clover. "On some gastropods of the Aegean" by D. C. Fielding and J. Edmunds. "Two historical *Pinna ingens* (Pennant) in the Royal Scottish Museum" by D. Heppell.

Lecture. "Faunas of the southern part of the North Sea with particular reference to the East Anglian Crags" by P. Cambridge.

Elections

Mrs. D. P. Alexander, 22 Estelle Rd., London, N.W.3.
F. G. Berry, 16 Temple Sheen Rd., London, SW14 7QG.
W. G. Buick, M. A., F.L.A.A., Box 139, Nedlands 6009, Western Australia.
D. Chrisp, 23 Forge Lane, Higham, Nr. Rochester, Kent.
M. J. Dawson Brown, The School House, Acaster Selby, Yorks.
Delaware Museum of Natural History, c/o R. Tucker Abbott, Box 3937, Greenville, Delaware, 19807, U.S.A.
G. F. Forsey, B. Sc., c/o Northampton College of Technology, St. Georges Ave., Northampton, NN2 6JB.
I. C. Gibson, flat 3, 47 Rectory Rd., Beckenham, Kent.
D. T. Giddings, 22 West Farm Ave., Middleton, Leeds, LS1Q 3SQ.
Mrs. M. Good, c/o G.P.O. Birr, Co. Offaly, Ireland.
Dr. E. S. Hall, Jr., 29 Trefoil Lane, Brockport, New York, 14420, U.S.A.
Hancock Museum, Barras Bridge, Newcastle-upon-Tyne.
P. Harrison, Forllwyd, Moelfre, Anglesey, N. Wales.
R. Ivell, B.A., University Museums, Parks Rd., Oxford.
J. K. Lee, 2 Preston Rd., W. Wimbledon, London SW20 0SS.
L. R. O. Mestre, Colina da las Nieves 36, Fracc. Bulevares Naucalpan, Edo de Mexico, Mexico.
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C. Nieh, Flat B, Marco Polo Mansion, Cleveland St., Causeway Bay, Hong Kong.
Dr. E. Pollard, Monks Wood Exp. Station, Abbots Ripton, Hunts.
L. Power, 94, Marden Rd., South Shields, Co Durham.
A. G. Reed, 33 Kings Cross Lane, S. Nutfield, Redhill, Surrey.
Dr. D. A. Reid, 2 Kew Cottage, Royal Botanical Gardens, Kew, Richmond, Surrey.
Mrs. N. Rostance, 157 Winchester Rd., Fordhouses, Wolverhampton, WV10 6EY.
Cmdr. F. Settepassi, Via G. Caccini, 00198, Roma, Italy.
Mrs. M. F. I. Smith, National Museum of Canada, Ottawa, Ontario, KIA OM8, Canada.
Mrs. M. F. Stribley, 7 Chaucer Rd., Bath, Somerset, BA2 4QU.
Miss J. Vinson, 55 Parkway, Ratton Manor, Eastbourne, Sussex, BN20 9DY.

882nd (ORDINARY) MEETING, 16 DECEMBER 1972

Lecture. "The art of eating and cooking shellfish" by J. E. Llewellyn Jones.

Elections

Miss J. M. T. Poynder, c/o Barclays Bank, 6 Market Place, Newbury, Berks.
D. Rawlinson-Plant, c/o 81 Bishops Rd., Trumpington, Cambridge.

883RD (ORDINARY) MEETING, 20 JANUARY 1973

Lecture. "Molluscs of the Trucial Coast" by Mrs. K. R. Smythe.

ELECTIONS

Mrs. W. M. Appleby, 47 Clarence St., Cheltenham, Glos. GL50 3JS.
L. W. Hill, F.Z.S., F.R.H.S., O.S.J., Chardwar, Bourton-on-the-Water, Glos., GL54 2BT
C. P. Palmer, 21 Upton Dene, Grange Rd., Sutton, Surrey.
Miss M. Smith, M.A., Apt. A-2, 11 Wildwood Gdns., Port Washington, N.Y. 11050, U.S.A.
Miss L. Sutty, B.P.20, St. Anne, Martinique, AF9Y2, F. W. I.
R. Townley-Malyon, 2 Stanley Villas, Ruskin Rd., Stanford-le-Hope, Essex.

MEMBER DECEASED

Rev. H. E. J. Biggs.

884TH (ANNUAL GENERAL) MEETING, 24 FEBRUARY 1973

Presidential Address. "Fictional Mollusca" by T. E. Crowley.
Election of auditors. W. F. Edwards and C. W. Pettitt were re-elected for 1973/74.

ELECTIONS

A. Cook, M.A., Ph.D., School of Biological Sciences, New University of Ulster, Coleraine, Co Londonderry, N. Ireland.
C. Hayton. 84 Hanley Rd., Stroud Green, London, N4 3DW.
Miss M. M. Milne, 2 Selby Terrace, Maryport, Cumberland, CA15 6NF.
Mr. and Mrs. Hesketh, 259 Western Ave., Dagenham, Essex, RM10 8UP (Family membership).

REPORT OF THE COUNCIL 1972–73

Membership. It is with deep regret that the Society has to report the deaths of the following members: I. Akerblom (1969/72), Mrs. H. P. V. Bailey (1963/72), Rev. H. E. J. Biggs (1919/73), C. P. Castell (1945/72), A. W. Stelfox (1903/72).

Membership now stands at 501. 49 new members were elected during the year, 17 have resigned, 23 have been removed for non-payment of subscriptions, 2 have transferred to the Subscribers list and 7 Juniors have transferred to Senior membership.

Meetings. One Annual General Meeting and 4 Ordinary Meetings were held in the Rooms of the Linnean Society of London, Burlington House, Piccadilly and 3 Ordinary Meetings have been held in the Conversazione Room at the British Museum (Nat. Hist.).

Publications. Three parts of the "Journal of Conchology", Vol. 27 Nos. 5/6 (Double Issue) and Vol. 27 No. 7, were published together with quarterly "Conchologists Newsletters", an Annual Membership List and a syllabus of Meetings. One "Paper for Students" appeared, No. 14 "British Littoral Mollusca".

REPORT ON JUNIOR MEMBERSHIP

The death of Rev. H. E. J. Biggs has deprived the Society of its Officer in charge (and founder) of Junior Membership. Dr. A. Rundle has been appointed to replace Rev. H. E. J. Biggs.

Membership now stands at 60. 18 new Members were elected during the year, 6 have resigned, 3 have been deleted for non-payment of subscriptions and 7 have transferred to Full Membership of the Society.

SUBSCRIBERS

Subscribers to the Journal of Conchology in 1972 totalled 145, taking 152 copies between them. Six have been removed for non-payment of subscriptions. 61 justified claims were received during the year; 44 for Vol. 27 No. 4. The Society purchased, or received gratis, from members 24 copies and is most grateful to these members. A further 50 copies of Vol. 27, No. 4 were reprinted to make up the outstanding claims.

There were 9 subscribers to the Newsletter and Papers for Students in 1972.

TREASURER'S REPORT, 1972

In comparison with previous years the Society's sources of income show an increase, as Members Subscriptions, payments by *Journal* Subscribers and investments are all higher than they have been before.

Unhappily there are also very substantial increases in expenditure, the chief causes being the continuing rises in the costs of postage, and of printing and duplicating. There is also the cost of hiring meeting-rooms, for which the Society has not previously been liable. Indeed the total cost of this item does not appear in the year's accounts since it was not possible to obtain the Linnean Society's bill in time for inclusion.

Three *Journal* parts were published in 1972, and of these Vol. 27 Nos. 5/6 appear in the accounts. Vol. 27 Nos. 7 appeared at the end of December and the bill for this has not yet been received. The publication of three parts has reduced the Society's publication delays, for which provision had been made by the retension of a large deposit account.

During 1972 the Society received a legacy of £500 from the estate of the late Mr. C. P. Castell, and the Council has approved the investment of this sum, together with a portion of the amount held in the deposit account, for the benefit of the general funds of the Society.

1973 will see the imposition of Value Added Tax. I am in touch with the appropriate department of H.M. Customs and Excise, but it is as yet impossible to say what, if any, effect this tax will have upon the finances of the Society.

Covenanted Subscriptions produced the useful addition of £103·50 to the subscription income. Changes in Income Tax will reduce the individual amounts which can be claimed after 1973, so that additional Covenanted Members would be most welcome.

20 Members and 6 Junior Members are at present in arrears with 1972 Annual Subscriptions; publications will not be sent to these Members pending the receipt of overdue subscriptions.

MARJORIE FOGAN
Hon. Treasurer

FIELD MEETINGS

Ten field meetings were held during 1972 as follows: 19 March, River Wallington, Sussex; 22 April, Leicester Area; 14 May, Miller's Dale, Derbyshire (joint meeting with the Malacological Society); 27 May, Sandwich, Kent; 10 June, Redgrave Fen, Suffolk; 2 July, Winchester, Hants; 5 August, Walton-on-the-Naze, Essex; 2 September, Highgate Cemetery, London; 1 October, Northampton (joint meeting with the Northampton Natural History Society); 22 October, Basingstoke, Hants.

Field meetings held by the Northwestern Conchological Group: 23 March, Freshfield; 8 April, Southport; 29 April, Hilbre Island; 11 May, Bryn near Wigan; 20 May, Haskayne; 15 July, Silverdale; 26 August, Crabmill Flash; 30 September, Withnell; 21 October, Southport; 18 November, St. Helens. Field meetings are also held by the Society's Yorkshire Branch.

Thanks are due to the following for leading these meetings: Rt. Hon. the Earl of Cranbrook, C.B.E., Drs. J. E. Chatfield, M. P. Kerney, J. Llewellyn Jones, C. R. C. Paul, L. Lloyd-Evans,

Miss S. Davies, Mrs. Bailey, Mrs. N. F. McMillan, Mrs. M. Fogan, Mrs. C. J. Pain and Messrs; B. Barrett, I. M. Evans, A. Norris, G. Osborn and G. E. Whitfield.

From 5–8 January, 1973, the Society held its first overseas field meeting to Majorca. The overwhelming support which this venture received justifies the hope that it may be possible to arrange another for 1974. We are particularly indebted to Dr. Chatfield and Mr. Barrett for the detailed organisation which did so much to make this meeting an outstanding success. A report has appeared in the Society's newsletter.

T. Pain

RECORDER'S REPORT: NON-MARINE MOLLUSCA

A. 10-Kilometre Square Mapping

Much valuable fieldwork was carried out in 1972 and another 14,000 10-kilometre square records were added to the master-cards. In August a special expedition was made to north-west Ireland (*Ir. Nat. J.* **17**: 310–316) and we are again grateful to the Royal Irish Academy for financial assistance.

Considerable progress has been made in the incorporation of old (pre-1950) data. The Society's MS. vice-comital census notebooks are the most important single source of information, containing details of some 70,000 lots examined by the non-marine referees from 1876 onwards. Extraction and gridding of this information is now largely complete. It is hoped to finish this work within the next twelve months, before map-making begins in 1974.

B. Vice-county Records

The following new records have been verified since the last Recorder's report (*J. Conch. Lond.* **27**: 562). Unless otherwise stated, the date of collection was 1972.

Devon North (4): *Arion lusitanicus,* Coryton (20/4483), M. J. and S. J. Bishop.
Somerset South (5): *Pisidium supinum, Pisidium hibernicum,* R. Parrett, Muchelney (31/4124), D. R. Seaward.
Hants North (12): *Vertigo substriata,* Adbury Park (41/4962); *Zonitoides excavatus,* Pamber Forest (41/6260), C. R. C. Paul.
Sussex East (14): *Acanthinula lamellata,* Balcombe (51/3130), B. Colville.
Essex South (18): *Acicula fusca,* South Weald (51/5894), D. R. Worth.
Essex North (19): *Milax sowerbyi,* Ashen (52/7442); *Agriolomax caruanae,* Little Bentley (62/1225), M. J. and S. J. Bishop.
Bucks (24): *Clausilia rolphii,* Akeley (42/6838); *Agriolimax caruanae,* Linslade (42/9125), Mrs E. B. Rands.
Norfolk East (27): *Milax budapestensis,* Potter Heigham (63/4120); *Agriolimax caruanae,* Sea Palling (63/4226), M. J. and S. J. Bishop.
Bedford (30): *Agriolimax caruanae,* Bledlow Manor (52/1138), D. G. Rands.
Gloucester East (33): *Anodonta complanata,* Tewkesbury (32/83), W. Nelson, before 1890 (Leeds City Museum).
Monmouth (35): *Vertigo substriata,* Cwm Coedycerrig (32/3021), S. P. Dance.
Hereford (36): *Agriolimax caruanae,* Tyberton (32/3839), M. J. and S. J. Bishop.
Warwick (38): *Agriolimax laevis,* Monks Kirby (42/4682), M. J. and S. J. Bishop.
Stafford (39): *Agriolimax caruanae,* Brewood (33/8807), M. J. and S. J. Bishop.
Salop (40): *Hygromia subrufescens, Zonitoides excavatus,* The Wrekin (33/6309), I. D. Finney; *Oxychilus draparnaudi,* Eyton upon the Weald Moors (33/5633), M. J. and S. J. Bishop.
Radnor (43): *Lauria anglica, Vitrina major,* Clyro (32/1144), S. P. Dance, 1973.
Carmarthen (44): *Vertigo substriata,* Abergorlech (22/5633), M. J. and S. J. Bishop.
Denbigh (50): *Planorbis crista,* Iscoyd (33/4846), M. J. and S. J. Bishop.
Lincoln South (53): *Agriolimax caruanae,* Long Sutton (53/4322), M. J. and S. J. Bishop.
Chester (58): *Arion lusitanicus,* Bromborough (33/3482), Mrs N. F. McMillan.

York South-west (63): *Pisidium moitessierianum,* Huddersfield (44/1115), R. Watkin.

York North-west (65): *Milax budapestensis,* Richmond (45/1605), A. Norris; *Agriolimax agrestis,* Hawes (34/8684), L. Lloyd-Evans.

Westmorland (69): *Vertigo antivertigo,* Shield on the Wall (35/8270); *Boettgerilla pallens,* The Abbey, Windermere (34/4098), B. Colville; *Vitrea diaphana* (form *subrimata*), Clouds Fell (34/7399), Lady Christina Letanka.

Edinburgh (83): *Planorbis vortex,* Hermiston (36/1669), T. Warwick.

Perth West (87): *Ena obscura,* Kippenrait Glen (26/7999), Mrs E. B. Rands.

Perth Mid (88): *Succinea oblonga, Agriolimax caruanae,* Broom of Dalreach (37/0017), Mrs E. B. Rands.

Sutherland East (107): *Helicella virgata,* Brora (29/9003), Dr Larch Garrad.

Sutherland West (108): *Helicella virgata,* Keoldale (29/3766), Dr Larch Garrad.

Caithness (109): *Aplexa hypnorum,* Iron Brig (39/3451); *Vertigo substriata,* Dunbeath (39/1430); *Pupilla muscorum,* Freswick Bay (39/3767); *Vallonia excentrica,* Castletown (39/2068); *Pisidium obtusale,* Loch of Killimster (39/3156), R. G. Meiklejohn.

All the Irish records which follow were made during the Society's mapping expedition in August 1972. The members of the party were Mrs M. Fogan, Mr A. Norris, Dr and Mrs M. J. Bishop, and the writer.

Galway North-east (H 17): *Anodonta anatina,* Ballaghdacke Lough (M 7857).

Roscommon (H 25): *Acicula fusca, Vallonia costata, Pisidium pulchellum,* Ballinlough (M 5878); *Vertigo substriata,* Cloonroe Bridge (M 5388); *Lauria anglica,* Strokestown (M 9483); *Acanthinula aculeata,* Dunamon (M 7866); *Acanthinula lamellata,* Ballinlough (M 6077); *Vallonia pulchella, Vallonia excentrica,* Drumsna (M 9897); *Milax budapestensis,* Dunamon Castle (M 7964); *Pisidium personatum,* Corramore (M 9844); *Pisidium henslowanum, Pisidium lilljeborgii,* Lough Ree, Cloonaddra (M 9869).

Mayo East (H 26): *Acicula fusca,* Lugboy House (M 4772); *Aplexa hypnorum,* Cuiltybo Lough (M 3385); *Planorbis carinatus,* Lough Nanoge (M 5090); *Planorbis leucostoma,* Newbrook House (M 2475); *Vertigo substriata,* Beaufield House (G 3016); *Acanthinula aculeata,* Annagh (M 4962); *Vallonia pulchella,* Mannin Lake (M 4584); *Vallonia excentrica,* Manulla (M 2187); *Oxychilus draparnaudi,* Hollymount House (M 2568).

Mayo West (H 27): *Planorbis carinatus,* Massbrook, Lough Conn (G 1705); *Cepaea hortensis,* Pollavullan, Ballycastle (G 0940); *Oxychilus draparnaudi,* Ballycroy (F 8010); *Milax budapestensis,* Pontoon (G 2003); *Agriolimax caruanae,* Gweesalia (F 7519); *Pisidium henslowanum,* Lough Alick (G 2114).

Sligo (H 28): *Vallonia pulchella,* Culleens (G 3529); *Arion fasciatus* seg., Banada Abbey (G 4610); *Agriolimax caruanae,* Killanly (G 2726).

Leitrim (H 29): *Marpessa laminata,* Sriff Cottage, Dromahair (G 7933); *Milax budapestensis,* Leckaun (G 8236).

1972 has seen another species added to the British list: the milacid slug *Boettgerilla pallens* Simroth (= *B. vermiformis* Wiktor), found by Dr. Colville near Windermere. The habitat is under stones among grass and nettles on a roadside verge. The species appears to be indigenous only in eastern Europe, but in the past few years has been reported at a large number of stations in west Europe and is apparently being spread by man.

Dr. Colville has also discovered a small colony of the north-western relict species *Acanthinula lamellata* in Sussex. The habitat, a marshy alder wood, is the same from which *Lauria anglica* was reported in 1969 (*J. Conch. Lond.* 27: 288).

Agriolimax agrestis has been found in north-west Yorkshire and will probably prove to be fairly widespread in the northern half of the British Isles. The new locality for *Vitrea diaphana* in Westmorland shows that this species, first detected in Britain only in 1966 (*J. Conch. Lond.* **27**: 17), is probably quite common in suitable habitats throughout the northern Pennines.

Among synanthropic species, *Agriolimax caruanae* is listed from a further ten vice-counties. *Helicella virgata* has been found commonly at two coastal sites in Sutherland, where it has perhaps become established only recently.

In Ireland, *Arion fasciatus* seg., previously known only from Co. Louth (*Ir. Nat. J.* **16**: 88), has been discovered in Sligo, also in a humanly disturbed habitat. The find of *Cepaea hortensis* near Ballycastle in Mayo West represents a considerable extension of known range. The determination was checked by an examination of the darts. *Marpessa laminata* has been found in Co. Leitrim at a second site by Lough Gill, about three miles east of the 1969 station in Co. Sligo (*J. Conch. Lond.* **27**: 287).

M. P. Kerney

RECORDER'S REPORT: MARINE MOLLUSCA

(Précis)

The new scheme for replacing the Marine Census Subcommittee by a team of Area Representatives is progressing well, with Representatives appointed for 39 of the 40 Areas; names and addresses with reports from the Areas will appear in the Society's *Newsletter*.

Since 1966, 176 people have offered to help with the Census, 60 of these having written to the Recorder after viewing a television programme ("Tomorrow's World") which described aspects of the work of the Biological Records Centre; "Conservation" appears to be the main motivation for wishing to be associated with the Society's recording work.

Field Cards are now available and the *Concordance to the Field Card* is in proof stage. The Society's Marine Census Areas have been adopted, with small modifications (agreed by the Society and shown on the special instruction sheet) by the Marine Fauna Committee of the Marine Biological Association.

Report on Areas

The following new or noteworthy records have been received during the year. Sea Area numbers are in brackets, and unless otherwise stated the date of collection was 1972.

Sutherland (2): *Thesbia nana* (Lovén), shell from Nun Bank 59°00′N 04°30′W in 62m., D. W. McKay: previously recorded only off Orkney and Shetland, last century.

Orkney (3): *Tellina squalida* Pulteney, single valve, strand line, Evie, A. Skene.

Firth of Forth, (7): *Teredo norvagica* Spengler, shells in driftwood, Gosford Bay, Dr. Shelagh Smith.

Wash (12): shells with facies of *Gibbula umbilicalis* (da Costa) were received from J. Llewellyn Jones and were determined by Mrs. N. F. McMillan as *G. cineraria* var. *ornata* Dautzenberg: presumably this is the coarsely marked form described by Dr. R. Hamond in his paper on the marine Mollusca of Norfolk (*Trans. Norfolk Norwich Nat. Soc.* **22**: 271–306, 1972).

Portland (16): the very local S. coast species *Truncatella subcylindrica* (L.) is recorded from The Fleet, clustered under plants of Seablite (*Suaeda fruticosa*), and Voucher specimens have been received of *Emarginula conica* Lamarck, low spring tide, The Fleet: both records come from D. R. Seaward, and the first confirms a record of 120 years standing, whilst the second seems to be the only reported occurrence of this species living between tide marks.

West Channel (18): *Alderia modesta* (Lovén), salt marsh in upper reaches of Fal, 1961, R. H. L. Disney.

Minch (30): *Buccinum humphreysianum* Bennett, living examples off Shiants East Bank, 57°57′N 06°03′W, D. W. McKay: this is a rare species of which there are only a few records, all from W. and N. Scotland and Ireland; *Turbonilla crenata* (Brown), single shell, Staffin, Skye; this record represents a northerly outpost for the species, and comes from Mrs. A. M. Brockbank; *Ammonicera rota* (Forbes & Hanley), shell, Loch Inchard, Mrs. J. L. Charlish.

S. M. Turk

Mollusks

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NOTICE

Payment by Overseas Members

Overseas members are reminded that all monies due to the Society are payable in sterling.

J. Conch. 28: 203–208 (1974)

BOETTGERILLA PALLENS SIMROTH, A NEW BRITISH SPECIES

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Leeds City Museums

(*Read before the Society, 20 October 1973*)

INTRODUCTION

On 3 September 1972, one of us (B.C.) collected near The Abbey, Windermere (NGR 34(SD)403985) three juvenile specimens of a slug which Dr. C. O. van Regteren Altena of Leiden subsequently ascribed to the genus *Boettgerilla,* a genus hitherto unknown in Britain. Further visits on 1 January and 6 April produced several adult specimens which we were able to establish as being *Boettgerilla pallens* Simroth, 1912 (= *B. vermiformis* Wiktor, 1959). Holotype in the Zoological Institute, Leningrad.

Publications on the identification of *Boettgerilla* are limited and difficult to obtain, and prior to this publication very little has been printed in English. The following account therefore is intended to fill this gap, as well as to report the occurrence of a new and interesting addition to our mollusc fauna.

B. pallens was first described from material collected at Gudauta near the town of Suchumi in the Transcaucasian region of the Soviet Union bordering the Black Sea, near to Ashary, the type locality for the closely related *B. compressa* Simroth, 1910. *B. pallens* can be separated from *B. compressa* by its smaller size and lighter colour, and by the lack in adult specimens of a bulb-shaped expansion on the end of the spermatheca; see Fig. 2.

Amongst Continental authors there has been considerable speculation as to the function of the peculiar spindle-shaped organ on the vas deferens. Simroth (1912 : 57) thought that it probably acted as an epiphallus and produced a spermatophore. Forcart, quoted by Schmid (1963 : 22), considers this unlikely, as the spindle is situated on the proximal portion of the male duct and the distal portion is so narrow as to make the passage of a spermatophore very difficult. Furthermore no spermatophore has yet been found in *Boettgerilla* and this

raises doubts as to whether the genus is correctly placed in the subfamily Parmacellinae. The nomenclature and systematic status of the genus will be fully discussed by Wiktor in his forthcoming monograph on the slugs of Poland.

DESCRIPTION

Body. The slug is very slender and worm-like, 3-5 mm broad, and normally 30-40 mm long, but attaining up to 60 mm when fully extended. Typically the colour is bluish-grey when adult and nearly white when very young (pl. VIIA). The dorsal keel extends from the posterior margin of the mantle to the tip of the tail; it is dark and laterally compressed, causing it to stand out like a sharp fin. The tail is slender and slightly obliquely truncated. The mantle shield has the form of a slightly rounded V at the hinder end and shows fine concentric grooves. The respiratory orifice is situated behind the centre of the mantle. The foot sole is narrow and pale with colourless sticky mucus. The tentacles are dark.

Shell. The shell is situated at the posterior end of the mantle and does not bulge up. It is very small, 1-3 mm in length, and symmetrical with an indistinct nucleus near the hind end. Around the edge of the shell is an irregular crystalline substance.

Anatomy. (Figs. 1, 2). The intestine forms two loops, the second reaching further back than the first. The vas deferens is short with a peculiar and very characteristic spindle-shaped swelling. The epiphallus is long and slender, joining the penis almost at its apex very close to the attachment of the penial retractor muscle. The penis is long and cylindrical, rather attenuated behind. The free oviduct is relatively short and thick. The spermatheca is elongate with a short duct ending in the free oviduct. The vagina is long and tubular. The right orbital retractor passes between the penis and the vagina. The atrium is very short and simple with the genital opening on the side of the body close behind and below the base of the right upper tentacle.

DISTRIBUTION

B. pallens was first collected in the Caucasus in 1905, and was probably introduced by man into western Europe where it has become widespread but sporadic in its distribution. It was first recorded from Poland in 1956 and since then has been reported in other countries of Europe (e.g. Schmid, 1962; Wiktor, 1972). In Germany it is now regarded as being one of the commonest slugs.

H. Zeissler (personal communication) records the occurrence of shell rudiments of *Boettgerilla* species in the Eem-interglacial tufa of Ehringsdorf and in the High-Eem of Taubach, East Germany. These records are interesting and suggest the possibility of its being native to that area of Europe, but the subterranean habits of this slug and the small size of the shell should be taken into account when assessing fossil records of this genus.

1

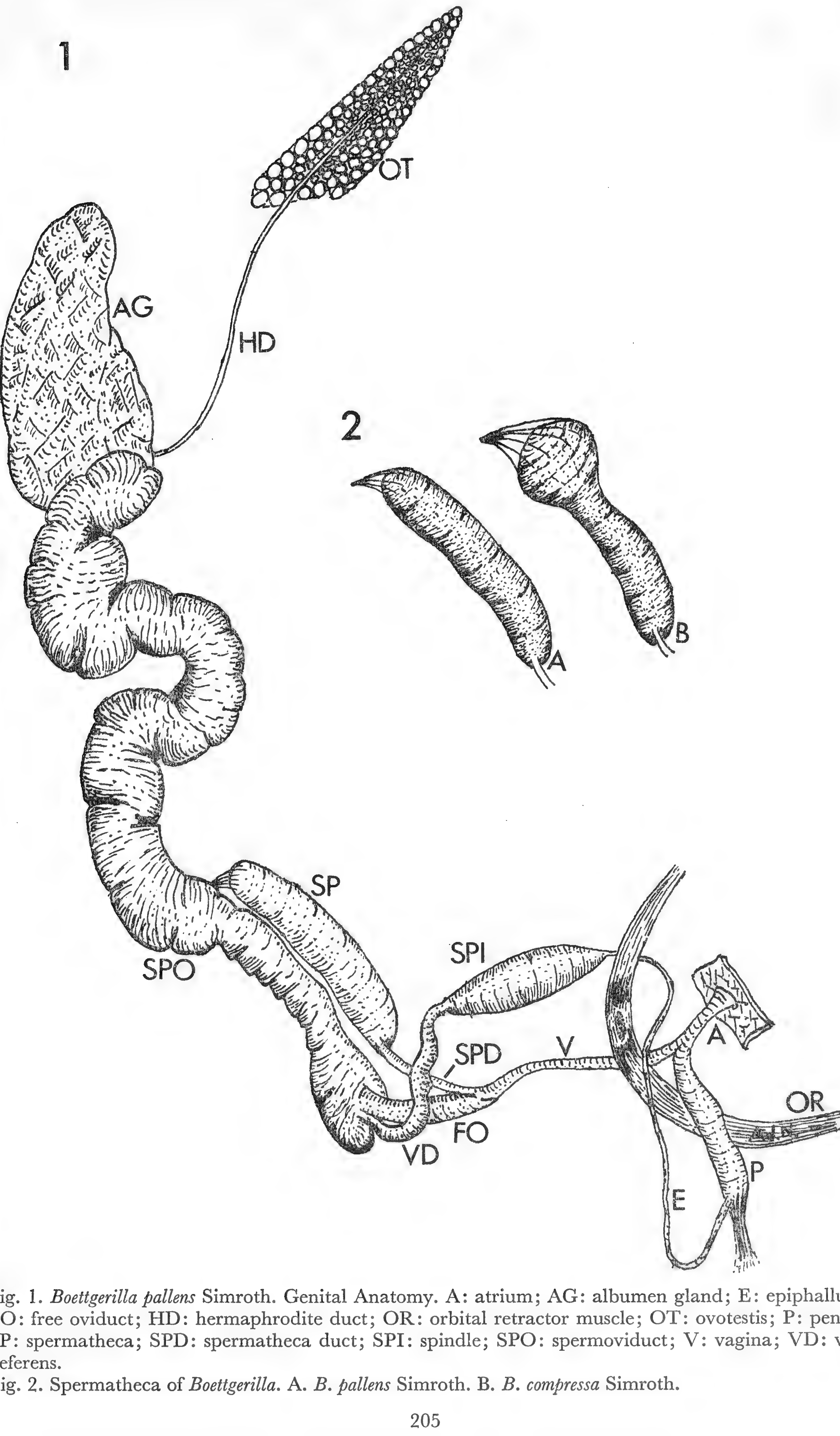

Fig. 1. *Boettgerilla pallens* Simroth. Genital Anatomy. A: atrium; AG: albumen gland; E: epiphallus; FO: free oviduct; HD: hermaphrodite duct; OR: orbital retractor muscle; OT: ovotestis; P: penis; SP: spermatheca; SPD: spermatheca duct; SPI: spindle; SPO: spermoviduct; V: vagina; VD: vas deferens.
Fig. 2. Spermatheca of *Boettgerilla*. A. *B. pallens* Simroth. B. *B. compressa* Simroth.

ECOLOGY

In general it is photophobic, finding refuge deep in the soil where its shape allows it to excavate galleries in much the same fashion as the earthworm (Wiktor, 1972). It can also be found under sunken stones or similar objects and occasionally under leaves or wood. In central Europe it is typically associated with disturbed ground, usually shaded by trees or shrubs in parks, gardens or graveyards, and occasionally in stony places shaded by dense herbage and in moist woodland in semi-wild conditions.

It is significant that *B. pallens* was first found in Britain at Windermere, a major tourist centre attracting numerous visitors from the continent of Europe. One site is in the field adjacent to a popular picnic area and car park; the other site, a short distance away on the lake shore, is connected to the first by a shallow gully and is also frequently visited by tourists and picnickers. Eggs or juveniles of *B. pallens* could have been transported to Windermere in mud on the vehicles or footwear of visitors from the Continent. The possibility of importation on the roots of plants was considered and visits were made to garden centres at Windermere and Ambleside. Several specimens of *B. pallens* were found at the Lakeland Garden Centre belonging to Mawson and Partners in Windermere (NGR 34(SD) 412983) about half a kilometre south-east of the known sites. This nursery may be the source of the introduction, but the other possibilities mentioned above cannot be ruled out.

The site adjacent to the picnic area and car park is a heavily trampled, damp corner of a field shaded by a large oak (*Quercus* sp.). The field has a slight south-west facing slope and is situated at an altitude of 60 metres. The ground cover is made up of *Ranunculus repens* L., *Rumex obtusifolius* L., and *Urtica dioica* L. with occasional specimens of *Silene dioica* (L.) Clairv., *Allium ursinum* L. and *Arum maculatum* L.

The site bordering the lake is divided into two sections, one of which is a small damp hollow by the side of an old dry-stone wall a few metres from the shore of the lake. The hollow is shaded by a tree layer made up of a mixture of silver birch (*Betula pendula* Roth.), beech (*Fagus sylvatica* L.) and ash (*Fraxinus excelsior* L.). The herb layer at this location consists of *Circaea lutetiana* L., *Urtica dioica* L., *Stachys sylvatica* L., *Valeriana officinalis* L., and *Allium ursinum* L. *Taraxacum officinale* Weber, *sensu lato, Rubus idaeus* L. and *R. fruticosus* L., *sensu lato*, are fairly frequent and there are also occasional specimens of *Endymion non-scriptus* (L.) Garcke, *Arum maculatum* L. and *Narcissus pseudonarcissus* L. The second section bordering the lake is in a wood which fringes the lake-side to the south of the wall. The tree layer here is made up mainly of wych elm (*Ulmus glabra* Huds.) with a shrub layer of *Ilex aquifolium* L., *Corylus avellana* L. and *Sambucus nigra* L. The herb layer consists mainly of *Mercurialis perennis* L., *Endymion non-scriptus* (L.) Garcke and *Allium ursinum* L., with frequent *Arum maculatum* L. and occasional specimens of *Lathraea squamaria* L. and *Narcissus pseudonarcissus* L. Both

these sites have a slight slope with a western aspect at an altitude of 45 metres.

In all the sites *B. Pallens* was found under stones set in a deep mull soil which was shaded, moist and base-rich.

ACKNOWLEDGEMENTS

We would like to thank all who have helped us with the preparation of this paper, in particular Dr. C. O. van Regteren Altena for identifying the original specimens; Dr. Andrzej Wiktor, Dr. Hildegard Zeissler and Dr. Herbert Ant for their help and guidance through the intricacies of nomenclature; and Dr. Günter Schmid for providing us with a number of very useful publications without which our task would have been much more difficult. Special thanks are due to Mr. A. E. Ellis and Dr. M. P. Kerney for their help and advice and to Dr. June Chatfield for her observations on the slugs under laboratory conditions.

ADDENDUM

BOETTGERILLA PALLENS SIMROTH, NEW TO IRELAND

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On the 1st of December 1973 one of us (R.A.) collected a single adult specimen of *Boettgerilla pallens* Simroth whilst on a visit to part of the Mountstewart demesne (IGR. J.555694) which lies on the shores of Strangford Lough 5 miles S.E. of Newtownards in County Down, Northern Ireland.

The locality, used mainly by picnickers and wildfowlers as a car park, is a small area of deciduous woodland isolated from other parts of the Mountstewart estate by the Newtownards-Greyabbey road to the east and the shores of the Lough to the west. The area has a very disturbed appearance due mainly to the ruins of a stone building, only two walls of which remain, the rest of the building having been strewn about the surrounding woodland. Consequently, large stones, plaster, bricks and slates, together with other rubbish such as tree stumps and dead weeds, litter the site and are disguised only by the remains of nettle beds *Urtica dioica* L. The wood itself is composed mainly of Sycamore, *Acer pseudoplatanus* L.

B. pallens was found lodged in a crevice at the jagged end of a log about 2 m long and 14 cm in diameter. This lay in a grassy unshaded hollow between the S.W. facing wall of the building and a grassy dyke bordering the sea lough. The distance between the dyke and the wall is about 3 m. In association with *B. pallens* on the jagged end of the undecayed log were 3 specimens of *Agriolimax caruanae* Pollonera, a species with which the area is infested. Other species in the area were *Cochlicopa lubrica* (Müller), *Clausilia bidentata* (Ström), *Hygromia striolata* (C.Pfe.), *Discus rotundatus* (Müller), *Arion hortensis* Fér., *Oxychilus draparnaldi* (Beck), *O. cellarius* (Müller), *Retinella nitidula* (Drap.), *Limax flavus* L. and *Agriolimax reticulatus* Müller.

An examination of the internal anatomy was undertaken for comparison with specimens taken at The Abbey, Windermere, and the following observations made. The Mountstewart specimen was very much larger than the largest adult found in the lake district, being fully 40 mm in length, whilst those from the original site averaged between 30-33 mm. The various parts of the internal anatomy were, therefore, relatively that much larger. The spermatheca duct proved to be completely deflated, but as far as could be established did not possess any sign of a bulb at the terminal end as in the closely related *B. compressa* Simroth. The spindle was disproportionately larger, measuring 6·43 mm as against 2·63 mm of the largest of the Windermere examples. The spindle also had a texture of finely wound silk of an irridescent silver-grey colour, a feature not detectable in the Windermere specimens.

We would like to thank Dr. S. Sutton of Leeds University for kindly measuring, so accurately, the two spindles.

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*The date 1919 is an error and should be 1912.

J. Conch. *28*: 209–212 (1974)

SPHAERIUM SOLIDUM (NORMAND) IN THE BRITISH ISLES

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(*Read before the Society, 16 March 1974*)

Sphaerium solidum (Normand) has hitherto been recorded in the British Isles as an early Pleistocene fossil from one deposit, at Little Oakley, Essex (Ellis 1962, p. 30). The species inhabits large rivers and canals in central and eastern Europe. It becomes less frequent in western Europe, having a very local distribution in the Netherlands, Belgium and northern France (Adam 1960, p. 359), to which we can now add Lincolnshire.

S. solidum is similar in size to *S. corneum,* with which it occurs, but is distinguished by its thick oval shell, marked with raised concentric ridges (Pl. VIIB, figs, 1, 4, 5; Adam 1960, fig. 160) which are much more prominent than in the fossil shell illustrated in Ellis (1962, pl. 11, fig. 1). The Lincolnshire specimens are glossy grey-brown, possibly owing to prolonged contact with mud. Fresh shells are described as pale yellowish, becoming greyer towards the umbo. The history of the discovery of *S. solidum* in Britain is as follows:—

On 30 May, 1973 one of us (E.J.R.), investigating 10 Km square TF (53)/16, sampled the River Witham from Kirkstead Bridge downstream to the confluence with Timberland Delph (a delph is a drainage ditch or dyke). In summer the river is much used for match fishing and carries numerous pleasure craft, some in passage from Boston to the river Trent via Lincoln and the Fossdyke. Along the section sampled the river runs in a clay channel and is slightly cloudy, but there is considerable vegetation and a varied invertebrate and fish fauna. The following Mollusca were recorded from the R. Witham: *Viviparus viviparus* (L.), *Bithynia tentaculata* (L.), *Planorbarius corneus* (L.), *Lymnaea auricularia* (L.), *L. peregra* (Müller), *Anodonta anatina* (L.), and *Sphaerium corneum* (L.). Timberland Delph was sampled for about 100 metres westwards from its confluence with the R. Witham. The Delph is an artificial watercourse, cut through the peat into the sticky, grey 'buttery' clay, draining across the Witham peat-fens from the Car Dike. The water was dark with little vegetation, although along the margins was a lush growth of *Glyceria maxima.* The greatest variety

of Mollusca was found about 50 metres west of the draw-doors at the junction of the two waterways (53/178611). Here there was stone and brick debris, perhaps from some older structure, and much grey organic mud.

Specimens of *Pisidium,* and of *Sphaerium* believed to be small *S. rivicola,* were sent to Dr. M. P. Kerney for identification. The *Sphaerium* were found to include immature *S. rivicola* and a valve of *S. solidum;* the shells were all quite fresh and not of fossil origin.

On 15 July, 1973 A.N. sampled the Delph at both ends (53/178611 and 135594). The junction with the Roman Car Dike at the western end of the Delph yielded considerable numbers of Mollusca, but little variety. Unlike the eastern end, this part of the watercourse supports dense aquatic vegetation and extensive algal bloom. The Car Dike was polluted with decomposing vegetation and contained few Mollusca. The Delph at its eastern end was sampled for a distance of one kilometre westwards from the draw-doors, but specimens of *S. solidum* were found only near the original station, where 27 valves were collected, four of which were still articulated. Living specimens were not found, and it was suspected that the shells had come from the R. Witham.

On 28 August E.J.R. visited similar sites along the R. Witham, where watercourses drained into the river. These sites were at Chapel Hill (Kyme Eau) 53/209540, Billinghay (Billinghay Skirth) 195565, and Short Ferry (Barlings Eau) 098713, at none of which was *S. solidum* found either in the river or the drains.

In examining *Sphaerium* collected by Mrs. E. B. Rands in 1968, A.N. detected *S. solidum* 'taken live' at Brothertoft (presumably Langrick Bridge, 53/266476), some way downstream from Timberland Delph. Dr. Barry Colville found one pair of fresh dead shells in the R. Witham at Tattershall Bridge (196562) on 17 February, 1974. Thus it seems likely that a viable population of *S. solidum* is present along about 15 kilometres of the R. Witham, although it is possible that the three sites represent distinct colonies.

A field meeting of the Conchological Society was organized on 17 March, 1974 to try to find a living colony of *Sphaerium solidum* in the R. Witham or its connecting drains. The stretch of the river investigated was from Stixwould Ferry to Brothertoft, between Lincoln and Boston. Particular attention was paid to the three localities from which *S. solidum* had been recorded, namely Brothertoft (TF(53)266475), Tattershall Bridge (196562) and Timberland Delph near Woodhall Spa (178611).

A single valve was taken in about two feet of water behind the pier of the bridge at Brothertoft, but apart from this the only specimens seen were in Timberland Delph, where dead shells were abundant, this visit and a subsequent one by Dr. A. J. Rundle producing more than 250 specimens, up to a fifth of which were articulated. A list of associated molluscs is given in Table 1.

The occurrence of *S. solidum,* all dead, in such large quantity poses a problem as to why this should be so. There appear to be several possibilities; the first and most striking observation is the large number of dead shells of Mollusca

TABLE 1

List of associated freshwater molluscs from the three known localities for *Sphaerium solidum*

Theodoxus fluviatilis (L.)	A	B	
Viviparus viviparus (L.)	A	B	C
Valvata cristata Müller	A	B	C
V. piscinalis (Müller)	A	B	C
Potamopyrgus jenkinsi (E. A. Smith)	A	B	C
Bithynia tentaculata (L.)	A	B	C
B. leachi (Sheppard)	A	B	C
Lymnaea truncatula (Müller)		B	C
L. stagnalis (L.)	A	B	C
L. auricularia (L.)	A	B	C
L. peregra (Müller)	A	B	C
Physa fontinalis (L.)	A	B	
Physa sp.	A	B	C
Planorbarius corneus (L.)			C
Planorbis carinatus Müller	A	B	C
P. planorbis (L.)		B	C
P. vortex (L.)	A	B	C
P. laevis Alder	A	B	
P. albus Müller	A	B	C
P. crista (L.)	A		C
P. contortus (L.)	A	B	C
P. complanata (L.)	A		C
Acroloxus lacustris (L.)			C
Ancylus fluviatilis Müller	A		C
Unio pictorum (L.)	A	B	C
U. tumidus Philipsson	A	B	C
Anodonta anatina (L.)	A	B	C
A. complanata Rossmässler		B	C
A. cygnaea L.			C
Sphaerium rivicola (Lamk.)	A	B	C
S. corneum (L.)	A	B	C
S. lacustre (Müller)	A		C
S. solidum (Normand)	A	B	C
Pisidium amnicum (Müller)	A	B	C
P. casertanum (Poli)			C
P. subtruncatum Malm	A	B	C
P. supinum Schmidt		B	C
P. henslowanum (Sheppard)	A	B	C
P. nitidum Jenyns	A	B	C
P. moitessierianum Paladilhe			C
Dreissena polymorpha (Pallas)	A		C

A = R. Witham, Langrick Bridge, Brothertoft, TF (53) 266475.
B = R. Witham, Tattershall Bridge, TF (53) 196562.
C = Timberland Delph, TF (53) 178611.

generally, particularly near the automatic gates, a very small proportion being found alive. This could be caused by material being washed down the Delph towards the gates, or into the Delph from the river. A search of the R. Witham near the gates failed to produce any *S. solidum*. The parts of the Delph upstream from the gates yielded a few dead shells, but they became progressively more scarce upstream. Another possibility is that *S. solidum*, like *S. rivicola*

(Lamarck) and *S. transversum* (Say), has an annual growth cycle, becoming adult at only one season, breeding and then dying out. At other times of year adults would be scarce or absent, and young ones too small to collect and identify. Further investigation should be made in June and July, the period when Mrs. Rands obtained her specimens.

The gratitude of the authors is expressed to Dr. M. P. Kerney, by whose acumen *Sphaerium solidum* was first identified from Lincolnshire.

Voucher material had been deposited in Leeds City museum, and the British Museum, Natural History, London.

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EXPLANATION OF PLATE VIIA

Boettgerilla pallens Simroth, The Abbey, Windermere.
Figs. 1, 4–5. An adult example active and resting.
Figs. 2 and 3. Two juveniles showing their paler colour.

EXPLANATION OF PLATE VIIB

Sphaerium solidum (Normand)
Figs. 1–3, 5–6. River Witham, Langrick Bridge, Lincolnshire. (Leeds City Museum). 1 and 2, external and internal surfaces of left valve. 3, dorsal view of both valves. 5 and 6, external and internal surfaces of right valve.
Fig. 4. Timberland Delph, Lincolnshire. External view of single valve (collection of A. Norris).

Plate VIIA

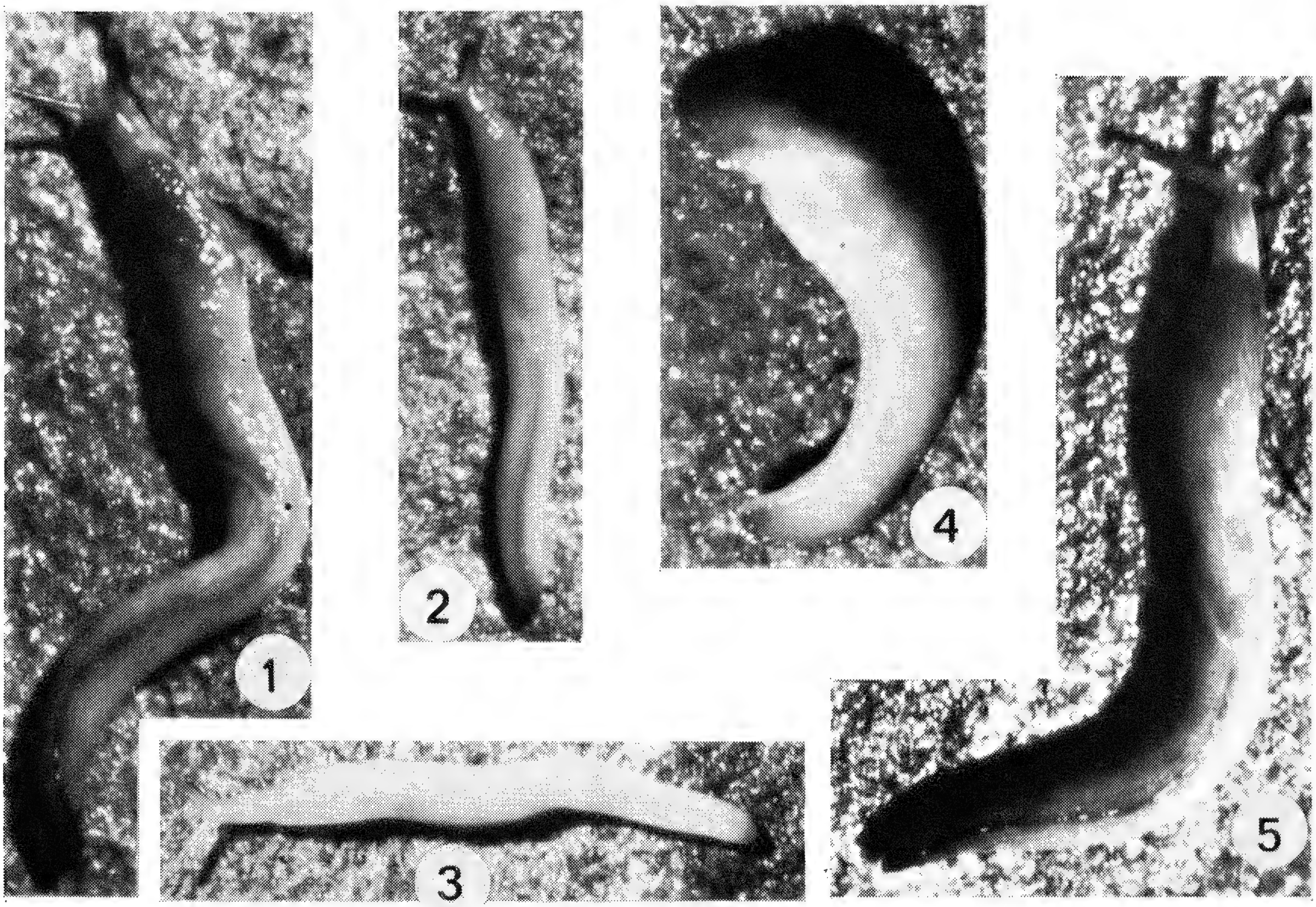


Plate VIIB

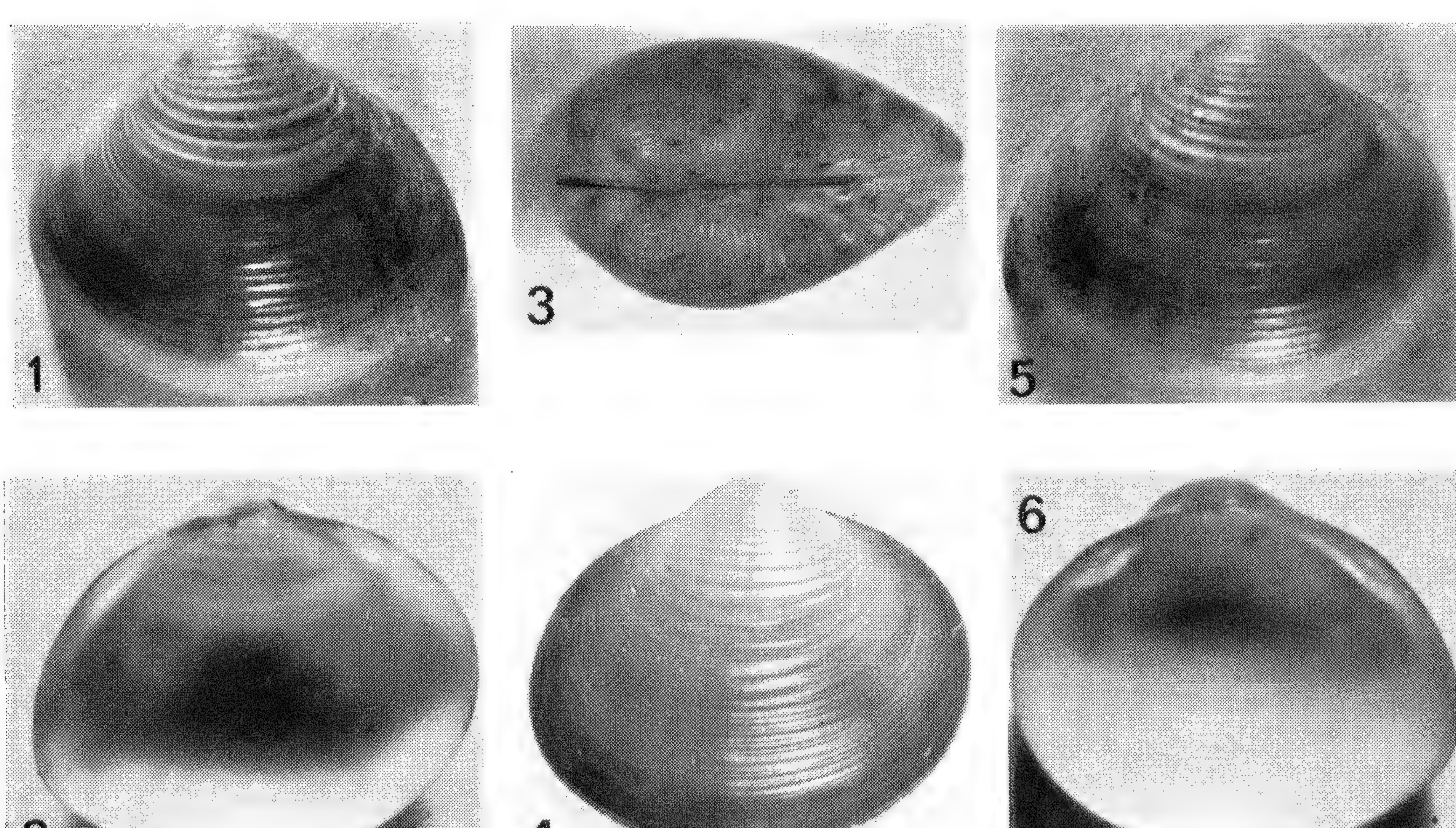
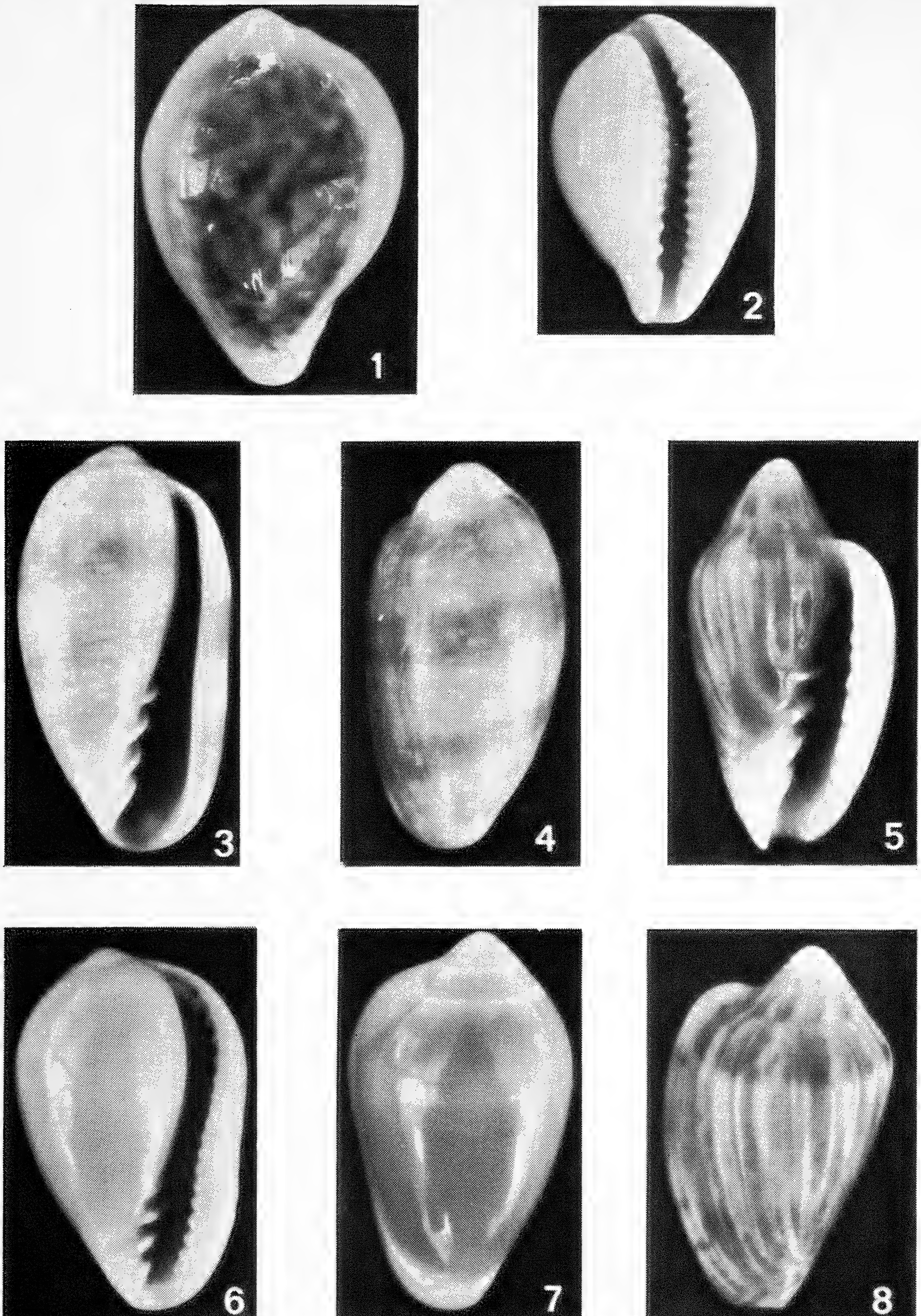


Plate VIII



J. Conch. *28*: 213–216 (1974)

A NEW SPECIES OF *CYPRAEA* FROM WEST AFRICA AND THREE NEW SPECIES OF MARGINELLIDAE FROM THE INDIAN OCEAN

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(*Read before the Society, 20 October 1973*)

Cypraea angelicae sp. nov. Plate VIII, figs. 1,2.

This distinct new species of *Cypraea* was discovered by Mr. Segiouloglou, a Greek businessman, who obtained the specimens from a Greek trawler, the *Evangelistria,* which trawls along the West African coast for shrimp in 20-80 fathoms of water.

Description. Shell small, heavy, pyriform, dorsum cream coloured and covered with patches of light brown; margins high, callous white, no lateral spots even in juvenile specimens; base also solid white, with fine evenly spaced teeth; aperture narrow, nearly straight, with a slight curve to the left posterior; fossula very weak, nearly smooth, with only a hint of inner denticles; interstices as wide as the teeth and flesh to light orange coloured. The holotype has 18 labial teeth and 16 columellar teeth.

DIMENSIONS (mm)	LENGTH	WIDTH	HEIGHT
Holotype, Manchester Museum EE 3667	24·9	17·5	13·7
Paratype, British Museum (Natural History) 1973.79	20·2	13·5	10·5
Paratype, Author's collection	20·3	14·4	10·6

EXPLANATION OF PLATE VIII

Cypraea angelicae sp. nov. Guinea, W. Africa.
Fig. 1. Holotype, Manchester Museum EE 3667. × 2 approx.
Fig. 2. Paratype, BMNH 1973–79. × 2 approx.

Volvarina pergrandis sp. nov. Oman. S. E. Arabia.
Fig. 3. Holotype, BMNH 1973.81. × 2·5 approx.
Fig. 4. Paratype, Author's collection. × 2·5 approx.

Glabella ansonae sp. nov. Reunion, Indian Ocean.
Fig. 5. Holotype, BMNH 1973.83. × 4·5 approx.
Fig. 8. Paratype, Author's collection. × 4·5 approx.

'*Marginella*' *spryi* sp. nov. Moçambique.
Fig. 6. Holotype, BMNH 1973.93. × 6 approx.
Fig. 7. Paratype, Author's collection. × 6 approx.

Type locality and range. Holotype trawled in sand and mud from 50-80 fathoms, 35-40 miles off Bissau, Portugese Guinea. Also known from 10-12°N, south to Sierra Leone in the same depth of water. The length of the 20 adult specimens examined varies from 19-27mm.

Basis for name. Greek for angel, the first name of Mr. Segiouloglou's lovely wife.

Discussion. C. angelicae is similar in size to *C. petitiana* Crosse, as figured in Burgess (1970, plate 6, fig. E) but differs in lacking the orange colour on the margins and base and in having no lateral spots as in *C. petitiana*. *C. angelicae* also has weaker, less numerous teeth for comparable size and moreover, the wider pyriform shape of *C. angelicae* clearly separates it from *C. petitiana*.

The holotype and one paratype were both collected alive but the animals were removed by a fisherman on the trawler.

Volvarina pergrandis sp. nov. Plate VIII, figs. 3, 4.

Description. Shell large for the genus, elongate oval, flesh pink coloured with numerous white irregular shaped specks over the entire shell and two darker pink spiral bands 3 mm wide, equally spaced on the body whorl; spire moderately elevated, consisting of $4\frac{1}{2}$ whorls, apex rounded; aperture moderately wide extending $\frac{4}{5}$ the length of the shell, flared anteriorly, inner edge of outer lip smooth and pink otherwise outer lip white, thickened, smooth and reflected externally, with two evenly spaced pink bands connecting with those on the body whorl and four strong oblique folds, equally spaced on the anterior half of the columella.

DIMENSIONS (mm)	LENGTH	WIDTH
Holotype, British Museum (Natural History) 1973.81	22·9	12·2
Paratype, Author's collection	22·1	11·8
Paratype, Manchester Museum EE 3571	24·7	11·4 (juvenile)

Type locality and range. Holotype found on a beach in sand and coral rubble near Muscat, Gulf of Oman. Also reported from Masirah Island and Salalah on the South Arabian coast.

Discussion. Unlike any other Indian Ocean species, *V. pergrandis* is only approached in size by *V. obscura* Reeve which occasionally grows to 20 mm. This unusual and large species is presently known from only four good beach specimens. The basis for its name is its size.

Glabella ansonae sp. nov. Plate VIII, figs. 5, 8.

Description. Shell medium to small sized, strombiform, white with about 20 faint interrupted light brown bands around the body whorl and two faint spiral bands of darker brown, one extending from the suture to the shoulder of the body whorl, the other on the anterior lower third of the body whorl; spire

elevated, conical, consisting of $5\frac{1}{2}$ whorls, apex rounded. Sculpture on the body whorl and spire consists of many fine axial ribs running the full length of the shell. (This is typical of shells of *Glabella,* particularly the West African species). Aperture narrow extending $\frac{3}{4}$ the length of the shell, slightly flared anteriorly and white within; outer lip heavy, flared at the shoulder and reflected outwards, white with 10-15 light brown spots on the outer edge. 10-12 denticles run the full length of the lip and are irregularly spaced. Four strong folds occur, the upper two nearly parallel, the lower two more oblique towards the canal.

DIMENSIONS (mm)	LENGTH	WIDTH
Holotype, British Museum (Natural History) 1973.82	11·6	6·4
Paratype, Author's collection	10·9	6·8

Type locality and range. Known only from sand and coral rubble on the beach of Trois Basins Reef, NW coast of La Réunion Island, Indian Ocean.

Basis of name. In honour of Mrs. Wendy Anson of Western Australia who has in the past seven years sent me many fine Indian Ocean species of Marginellidae for my studies of this family.

Discussion. Of the few species of *Glabella* found in the Indian Ocean this is the second largest. It appears to be related to the much larger (20-25 mm) *Glabella obtusa* (Sowerby) from the Gulf of Aden. *G. ansonae* differs in being much smaller, in having a lighter and less distinct colour pattern of interrupted spiral bands. It is also more slender with almost twice as many axial ribs as *G. obtusa* of comparable size.

"Marginella" spryi sp. nov. Plate VIII, figs. 6, 7.

Description. Shell small, ovoid, solid white or light orange with a glossy surface; spire low but completely visible and consisting of $4\frac{1}{2}$ whorls; aperture narrow extending $\frac{9}{10}$ the length of the shell, curved, constricted slightly in the centre and white within; outer lip white, thickened, smooth and reflected externally, with many heavy denticles within running the full length of the aperture; four short strong, slightly oblique folds set low on the columella.

DIMENSIONS (mm)	LENGTH	WIDTH
Holotype, British Museum (Natural History) 1973.83	9·5	6·0
Paratype, Author's collection	9·9	5·9
Paratype, Manchester Museum EE 3752	8·2	5·3

Animal. Not seen by the author but reported to be light orange.

Type locality and range. Holotype found alive at low tide under stones about 150 miles south of Porto Amelia, Moçambique. *"M." spryi* has also been collected from Sinda Island off Dar es Salaam, Tanzania and Shimoni, Southern Kenya.

Basis of name. In honour of Mr. John F. Spry of Nairobi, Kenya who first brought this species to my attention.

Discussion. "*M.*" *spryi* is quite unlike any other Indian Ocean species except for the size and white colour of "*M.*" *monile* L. which is found all along the East African coast. "*M.*" *spryi* has also been confused with, and called, "*M.*" *margarita* Kiener. This is an error since the latter is a West Indian species similar in size only, but which was listed from India in older reference books.

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J. Conch. 28: 217–224 (1974)

MOLLUSCA DREDGED OFF MUSSELBURGH, FIRTH OF FORTH, SCOTLAND IN 1972, WITH PARTICULAR REFERENCE TO THE POPULATION OF *SPISULA SOLIDA* (L.)

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(Read before the Society, 16 March 1974)

INTRODUCTION

During June and July 1972 some 300,000 tonnes of sand were deposited on the beach at Portobello near Edinburgh. The sand, raising the height of the beach by an average of 2·5 m over a stretch of 1·6 km, was to provide the first line of defence against winter storms which threaten the sea wall and adjacent property. It also has improved the shore amenity by producing a large area of sand not covered at high tides.

The sand was lifted by a bucket dredger working in about 4 m of water a short way along the coast off Musselburgh [36/340745] and conveyed by barge to a pumping vessel moored off Portobello [315742], where it was mixed with water, pumped up a pipe and spread along the shore. With the sand came bottom-dwelling organisms from amongst which were collected live and dead molluscs. Despite their rough treatment many had survived and were initially active, trying to burrow into the temporarily unstable foreshore, but most were eaten by gulls or died and rotted in the sun. Table I *col.* 1 shows the species collected while the pumping was in progress. Three months later the shell content of Portobello strandline (Table I *col.* 3) differed from what it had been prior to the addition of the new sand (Table I *cols.* 4/5) only by containing slightly larger amounts of *Spisula solida* (L.) valves, very few of which were articulated.

QUALITATIVE SAMPLING OF THE MOLLUSC POPULATION

Table 1 *col.* 1 is assumed to be representative of the mollusc population actually present in the Musselburgh area. Dredging commenced at the south-western end of a traverse [330740] where the sand contained little apart from *S. solida*, but as the dredger moved north-eastwards dead *Turritella communis* Risso additionally came up in abundance. Farther still to the north-east the material was at its richest and contained most of the species collected. The sand

TABLE 1 (list of species)

	1	2	3	4	5	
Lepidochitona cinereus (L.)		fcL				
Patella vulgata L.	sp		sp	sp	sp	common live on adjacent rocky shore.
Acmaea testudinalis (Müller)					r	very rare live on adjacent rocks.
Gibbula cineraria (L.)	r		sp	sp	sp	sparse, live on adjacent rocks.
Littorina littorea (L.)	sp		sp	cL	cL	very common, live on rocks between Portobello and Musselburgh.
L. saxatilis (Olivi)	r			sp		
L. littoralis (L.)	r			sp	sp	
Turritella communis Risso	**vc***		fc	c	c	*part of old substrate.
Aporrhais pespelecani (L.)	r		r	r	r	
Natica catena (da Costa)	sp					
N. alderi Forbes	sp			r		
Nucella lapillus (L.)	sp		fc	fc	fc	very common, live on adjacent rocks.
Neptunea antiqua (L.)	sp			r		
Buccinum undatum L.	**spL**	**cL**	sp	sp	sp	
Nassarius incrassatus (Ström)				r		
Mangella nebula (Montagu)	r*					*part of old substrate.
Philine aperta (L.)	r			r		
Nucula sulcata Bronn				r		
Heteranomia squamula (L.)				r		
Mytilus edulis L.	**fcL**		**fcL**	**cL**	**vcL**	
Modiolus modiolus (L.)	r	**cL***				*from slightly deeper water.
Ostrea edulis L.	sp*		sp	sp	sp	*part of old substrate, all old dead shells.
Pecten maximus (L.)				r	r	
Chlamys opercularis (L.)	**spL**	**cL**		r	r	
Thyasira flexuosa (Montagu)				sp		
Arctica islandica (L.)	r		sp	r		
Lucinoma borealis (L.)				r		
Acanthocardia echinata (L.)	r		sp	r		
Parvicardium scabrum (Philippi)				sp		
Cardium edule L.	sp		fc	sp	c	

TABLE I (continued)

	1	2	3	4	5	
Dosinia lupinus (Montagu)	**spL**			r		
Venus striatula (da Costa)	**cL**	**cL**	sp	c	c	
Venerupis pullastra (Montagu)	**rL**			sp	sp	
Mysia undata (Pennant)			r	sp	sp	
Donax vittatus (da Costa)	sp		sp	fc	sp	
Tellina tenuis da Costa	**fcL**		fc	fc	fc	
T. fabula Gmelin	**cL**	**fcL**	sp	c	c	
T. crassa Pennant					r	
Macoma balthica (L.)	**spL**		r	fc	**fcL**	
Scrobicularia plana (da Costa)					r	
Abra alba (S. Wood)	**fcL**		fc	fc		
A. prismatica (Montagu)	r				r	
Gari fervensis (Gmelin)	r		r	sp		
Ensis ensis (L.)	**spL**					
E. arcuatus (Jeffreys)	r		r	r		
E. siliqua (L.)	**spL**		r	sp	sp	
Mactra stultorum (L.)	sp		r	**cL***	sp	*cast-up in quantity after a storm.
Spisula solida (L.)	**vcL**	**cL**		sp	sp	
S. subtruncata (da Costa)	**cL**		fc	fc	fc	
Mya arenaria (L.)	**spL**	**cL**	**spL**	**spL**	fc	
M. truncata L.	**spL**			sp		
Lutraria lutraria (L.)				sp	sp	
Corbula gibba (Olivi)	sp		c	c		
Hiatella arctica (L.)		**spL***		r		*from slightly deeper water common dead in rocks.
Barnea candida (L.)	sp		r	sp		
Zirfaea crispata (L.)			r	sp		
Thracia phaseolina (Lamarck)	**spL**					

1; dredged from off Musselburgh in 1972. 2; Lothians River Purification Board samples 1970–71. 3; strandline at Portobello, 1972. 4; strandline at Portobello, 1966–67. 5; strandline at Musselburgh, 1966–67.
L; live. vc; very common. c; common. fc; fairly common. sp; sparse. r; rare. Important species are shown in heavy type.

from the north-eastern end [341746] had a poor fauna, however, and pebbles, *Fucus* and *Littorina* suggested that shallower water at the pebbly delta of the river Esk (which enters the sea at Musselburgh) had been reached. The molluscs thus obtained, and those in recent grab and trawl samples taken by the Lothians River Purification Board (Table I *col.* 2), reveal an abundant fauna not entirely apparent from an examination of the strandline material (Table I *cols* 3/4/5), but show that the living source for the strandline shells lies very near at hand. The live shells were all of good quality with even growth lines and few were distorted, and thus were seemingly little affected by pollution, although the sea close off Musselburgh is regarded as Class II (fairly good quality but significantly polluted) and in a restricted zone off Edinburgh is Class III (poor quality) (Scottish Development Department, 1972, p.7-8 and Map C).

The mollusc fauna is typical of a sublittoral sandy sea bottom in north-east Britain. The chief predatory species appears to be *Buccinum undatum* L. The *Natica* shells were much fresher than those commonly collected from a strand-line, but contained no soft parts and so the presence of these as predators is not confirmed. *Mytilus edulis* L., commonly regarded as a rock-dwelling animal, is not thought to have been taken from an odd rock outcrop or accidentally introduced. The species lives in quantity on the sand at low water at Portobello and Musselburgh and it is expected that its range in this habitat continued to the depth investigated. The association of *Modiolus modiolus* (L.) and *Hiatella* arctica (L.) was due to the additional presence of *Alcyonium* which adhered to *M. modiolus*, the base forming a major habitat for *H. arctica*.

The dead *T. communis* were apparently from a clearly defined bed. Despite a thorough search involving breaking open many fresh shells, no live specimens were seen. Other beds (some also dead) in the Firth of Forth occur in slightly deeper water. Stephen (1933, p.606) stated "Its areas of high density lay within the Coastal Zone [4m-40m]". The only recent live record is of specimens taken on a muddy bottom with wreckage in 50 m (D. W. McKay leg., 1973). The shells at Musselburgh seemed too fresh to be part of an ancient community formed when the sea level was higher than it is at present. Rather, they indicate a population living at the extreme end of its environmental range, possibly succumbing when the sand, ideal for the present fauna, was deposited (McMillan 1957, p.196).

ANALYSIS OF SHELL GROWTH

Analyses were restricted to live shells in order to discover if rates of growth varied in any particular year, by means of relating growth increments to particular years, the assumption being that the last increment belonged to 1972. Size-frequency histograms of the three commonest species taken live show that *Venus striatula* (da Costa) had a fairly even growth distribution (Fig. 1a) from which no year classes could be detected. This may indicate that growth was continuous throughout the year. *Spisula subtruncata* (da Costa) peaked

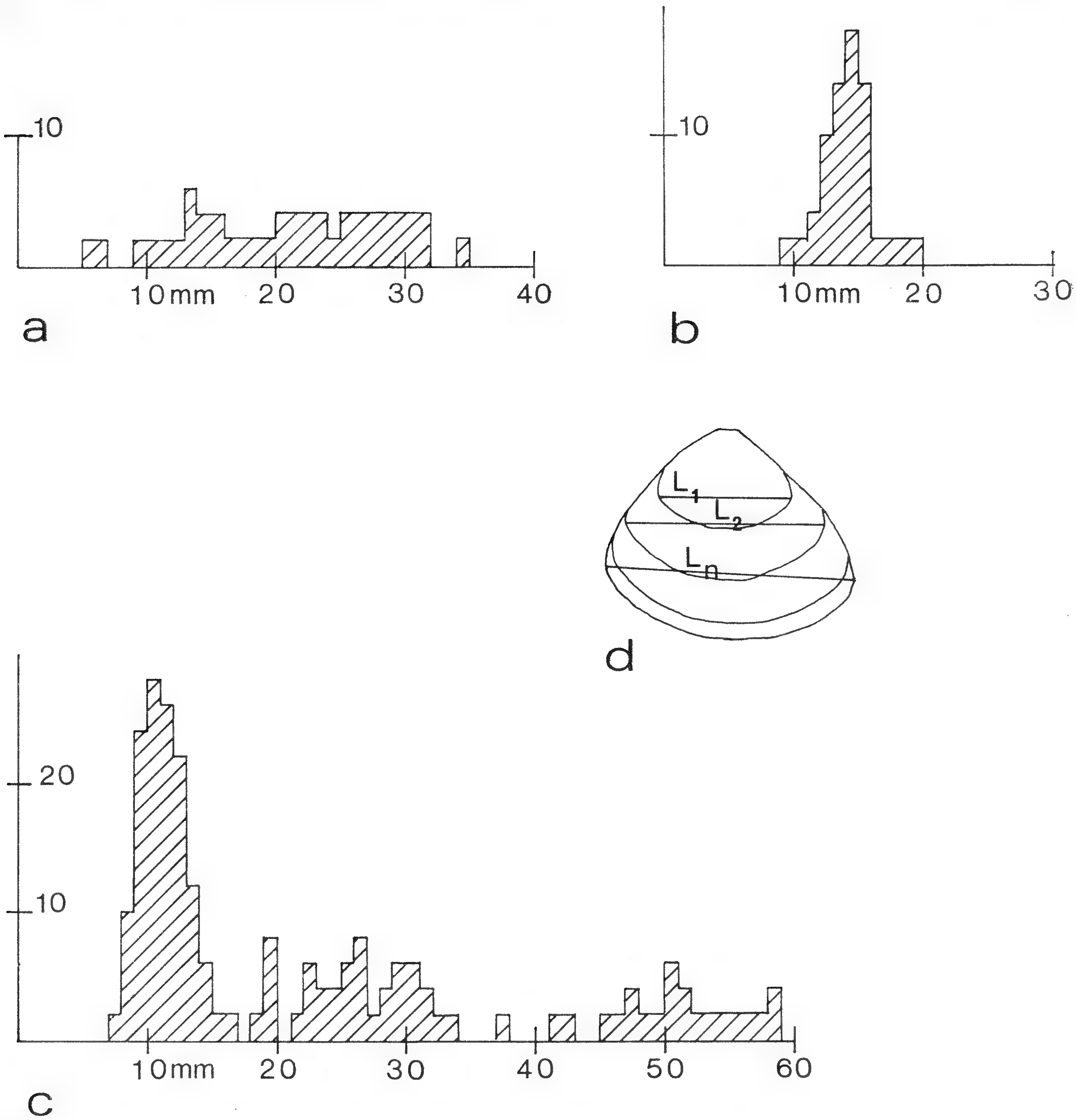

Fig. 1.

a). Size-frequency histogram of *Venus striatula* showing an even distribution of sizes of animals.

b). Size-frequency histogram of *Spisula subtruncata* showing a marked peak at 15 mm.

c). Size-frequency histogram of *Spisula solida* showing peaks corresponding with the <1 year old 1972 class, the <2 year old 1971 class and shells over three years old (1969 and 1968 year classes). The gap at 40 mm is caused by the absence of the 1970 year class.

d). Diagram of *S. solida* shell showing the winter growth check lines and the linear measurements L_1, L_2, L_n where L is the length of the shell at growth check (or death). Growth increments are thus $L_2 - L_1$ etc.

markedly (Fig. 1b) at 15 mm and had no winter growth check lines. The shells were much smaller than those found in 1966-67 when the average length was 25 mm with a growth check line at 20 mm. By comparison with *S. solida* it is probable that these were young animals belonging to one year class, possibly indicating a new establishment of a colony.

The size-frequency histogram for *S. solida* (Fig. 1c) shows three main peaks. These are formed of shells with no winter growth check lines culminating at 10 mm, shells with one line grouping between 22 mm and 31 mm, and those with two or more between 45 mm and 59 mm. They represent groups of shells belonging to classes of < 1 year, < 2 year and those over two years old. The winter growth check lines are similar to those in species such as *Venus mercenaria* L. (Ansell, 1964; Ansell *et. al.*, 1964) and *Cardium edule* L. (Cole 1956, p.84; Hancock 1965, p.341). Very small shells containing soft parts or live animals were not present. Small dead shells (3-6 mm) were found after the main collection was completed in several distinct patches corresponding to the sites of outfall from the distribution pipe, and it is reasonable to suppose that had live shells of this size been initially present they would have been found at these localities. Because of the force of the pumped water/sand mixture these areas were not readily accessible to the gulls. There was no trace of small shells in gull droppings. Thus the absence of small live shells appears to have been original and attributable neither to sorting nor predation.

Comparison shows that the mean size of those shells without winter growth check lines is 12 mm (Table II), while the growth up to the first winter growth check lines on the older shells is considerably more, that of the 1971 year class being 18 mm, and that of 1969 21 mm, and of 1968 16 mm. The absence of a growth check at a very early stage of any of the shells suggests that the breeding period occurred during the winter and that this year's brood (1972) had not completed its annual growth at 12 mm. The amount of growth already obtained is in itself sufficient to explain the lack of small shells.

Table 2

Growth increments in mm (year class per year)

	1968	1969	1970	1971	1972	
1st year	16	21		18	12	1972 year class
2nd year		14	14		9	1971 year class
3rd year			12	9		
4th year				7	7	1969 year class
5th year					4	1968 year class

The middle-sized shells (20-35 mm) generally had only one winter growth check line, whereas the larger ones had three or more. This indicates that the 1970 year class was a poor one with few individuals becoming established in the Musselburgh area. The second season's growth in the 1971 year class is 9 mm, while that of the older shells is 14 mm. This again shows an incompleted year's growth up to June 1972. With even older shells the pattern is less pronounced as growth becomes slower, the complete 3rd increment being no more than 12 mm and the 4th about 7 mm. Few shells with more than four winter growth check lines were found, and it seems likely that the normal life span of *S. solida* here is five years.

Growth increments were measured for approximately 200 shells of *S. solida*. The average length of the shells of each year class up to each successive winter growth check line was measured (Fig. 1d) and the calculated increments were then tabulated so that the average amount of growth accrued by each year class in any one year could be shown separately (Table II). Thus the 1968 year class grew 16 mm in 1968, the increment diminished to 7 mm in 1971 and to 4 mm in the incomplete 1972 season. In 1970 the 1969 year class grew 14 mm in its second year of growth, and the 1968 year class grew 12 mm in its third year of growth. These figures do not compare unfavourably with the second year's growth of the 1968 class in 1969 (14 mm) and the third year's growth of the 1969 class in 1971 (9 mm), and suggest that in 1970, the year when breeding failed, growth was normal.

DISCUSSION

S. solida formed part of a healthy bottom community which seems to have been thriving for some considerable time. The beds cannot have been disturbed to any great extent, parasitized, diseased or polluted during the 1970 growing season in a manner affecting the older animals. Any such disturbance during the winter breeding has left no trace on them. Considerable effort was made to try and find the reason for the absence of the 1970 year class, and in view of the lack of evidence of any disaster in the older animals it is inferred that more likely than not, breeding took place normally and subsequently the spat were removed and/or killed. Insufficient information was available on sea temperatures and salinity but comprehensive meteorological data for the period 1968-1972 were analysed. There was no pattern peculiar to 1970 either of wind, from which storms, calm periods and air temperatures can be deduced, or of rainfall which would have affected the salinity of the water and possibly the dilution of normal pollutants flowing out of the river Esk. Thus the failure to establish the 1970 year class appears to have been the result of an ephemeral and coincidental condition which occurred at a time when the spat were extremely vulnerable.

ACKNOWLEDGEMENTS

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MAPPING NON-MARINE MOLLUSCA IN SOUTHERN SCOTLAND, 1973

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(*Read before the Society, 16 March 1974*)

Between 17 and 28 September, 1973 a party of members of the Society (Mrs. M. Fogan, Mrs. E. B. Rands, D. C. Long, A. Norris, C. R. C. Paul, A. J. Rundle and the writer) visited southernmost Scotland and the Border country, a region previously little studied from the molluscan point of view. We are grateful to the Carnegie United Kingdom Trust for a grant towards our expenses. The region is not on the whole favourable for molluscs. Much of the land lies above 1,000 ft., and consists entirely of Palaeozoic rocks. The soils are mostly non-calcareous, there being virtually no limestone apart from some thin horizons in the Ordovician around Girvan in south Ayrshire, and the local bands in the Carboniferous in north Ayrshire and Lanarkshire. The rainfall is mostly between 40 and 60 inches. There are very extensive tracts of acid moorland, in places planted with conifers. Deciduous woods are very few, though remnants of primary mixed oak woods survive in some of the valleys, especially in the west of the area. Marshes are uncommon and mostly oligotrophic. The majority of the rivers contain soft water and are shallow and fast-flowing, with a fresh-water fauna generally limited to *Ancylus* and *Lymnaea peregra*.

Working from Cumnock, Ayrshire (six days), Moffat, Dumfriesshire (three days) and Hawick, Roxburghshire (two days) we covered over 2,500 miles, sampling 128 contiguous 10-kilometre grid squares lying in Watsonian vice-counties 67, 68, 70, 72, 73, 74, 75, 76, 77, 78, 79, 80 and 81. The field procedure adopted was to select and examine a representative spectrum of the habitat types available in each grid square, visiting, for example, a wood, a stone wall, a river and a marsh. We attempted in each square to list at least 50-60% of the total estimated number of species present. The regionally commoner molluscs quickly emerge in this way, and from the point of view of a national survey it is precisely these so-called "common" species (rarely so over the whole of their ranges) about which data are most needed and which are likely to provide biogeographical information of the greatest value. The rarer species were less easily detected by this method, but inevitably during such a wide-ranging survey a number of interesting discoveries were made, details of which are given below.

Ninety-six species of molluscs were recorded. Their relative frequency within the area may be broadly expressed as follows:

Found in more than 100 squares sampled (total 128):

Ancylus fluviatilis, Cochlicopa lubrica, Discus rotundatus, Arion circumscriptus (agg.), *A. ater, Oxychilus cellarius, O. alliarius, Retinella nitidula, Vitrina pellucida, Agriolimax reticulatus.*

Found in 75 to 100 squares:

Lymnaea peregra, Lauria cylindracea, Hygromia hispida, Arion intermedius, A. hortensis, Vitrea crystallina, V. contracta, Retinella radiatula, R. pura, Agriolimax laevis.

Found in 50 to 75 squares:

Carychium tridentatum, Cepaea nemoralis, Hygromia striolata, Punctum pygmaeum, Arion circumscriptus circumscriptus, A. circumscriptus silvaticus, A. subfuscus, Euconulus fulvus, Limax marginatus.

Found in 25 to 50 squares:

Potamopyrgus jenkinsi, Carychium minimum, Lymnaea truncatula, Succinea pfeifferi, Cochlicopa lubricella, Acanthinula aculeata, Clausilia bidentata, Arianta arbustorum, Cepaea hortensis, Hygromia subrufescens, Arion fasciatus, Agriolimax agrestis, A. caruanae, P. casertanum, P. personatum, P. subtruncatum, P. nitidum.

Found in 5 to 25 squares:

Valvata piscinalis, Planorbis albus, P. contortus, Columella aspera, C. edentula, Vertigo antivertigo, V. substriata, Acanthinula lamellata, Vallonia excentrica, Balea perversa, Helix aspersa, Monacha granulata, Arion hortensis form "B", *Zonitoides excavatus, Milax budapestensis, Limax maximus, Sphaerium corneum, Pisidium amnicum, P. milium, P. hibernicum.*

Found in 2 to 5 squares:

Valvata cristata, Acicula fusca, Hydrobia ulvae, Lymnaea palustris, Physa fontinalis, Planorbis leucostoma, P. crista, Succinea putris, Vertigo pusilla, V. lilljeborgi, V. pygmaea, Lauria anglica, Ena obscura, Clausilia dubia, Helicella caperata, Oxychilus draparnaldi, Zonitoides nitidus, Limax cinereoniger, Pisidium lilljeborgii.

Found in one square only:

Bithynia tentaculata, Planorbis carinatus, P. laevis, Segmentina complanata, Acroloxus lacustris, Succinea oblonga, Vallonia pulchella, Milax sowerbyi, Limax flavus, Sphaerium lacustre, Pisidium obtusale, P. pulchellum.

It is interesting to compare these frequencies with the situation in a tract of country of comparable size in north-west Ireland (Mayo/Sligo/Roscommon/Galway) surveyed in a similar way in 1972 (Kerney, 1973). *Discus rotundatus* and *Oxychilus alliarius* were significantly rarer there, being found in only 77% and 66% respectively of the grid squares visited, as against 95% in Scotland. On the other hand, the most abundant mollusc in north-west Ireland is *Lauria*

cylindracea (99% of squares), a western oceanic species which is distinctly local in the Southern Uplands (59% of squares). The Mediterranean species *Helix aspersa* similarly makes a much poorer showing in Scotland (5% as against 67% of squares in Ireland). Differences of this kind tend to be entirely masked by the old pattern of vice-comital recording, but are revealed clearly by the technique of systematic grid mapping.

NOTES ON SELECTED SPECIES

All information collected during the survey, including some 3,000 species records, has been incorporated in the general bank of data intended for the forthcoming *Atlas of non-marine Mollusca*. The following notes however draw attention to certain records of special interest. The number in parenthesis indicates the number of 10-kilometre squares (out of 128) in which the species was noted. An asterisk (*) indicates a new vice-comital record, a full list of which is published in the Recorder's Report (see p. 257).

Valvata cristata Müller (2). Belston Loch, v.c.75 (26/4716); Yetholm Loch, v.c.80 (drain, 36/805285).

Acicula fusca (Montagu) (4). A relict woodland species, rare in Scotland. Glenluce, *v.c.74 (mixed deciduous wood, 25/191574); Croy Brae, v.c.75 (mixed deciduous wood, 26/256132); Kilmarnock, v.c.75 (beech wood, 26/463327); Noddsdale, v.c.75 (ash wood, 26/222637).

Hydrobia ulvae (Pennant) (2). *Spartina* marsh on shores of Solway Firth in 35/16 and 35/26.

Potamopyrgus jenkinsi (Smith) (30). This introduced species is probably still actively extending its range in Scotland, though not yet found over large areas. The earliest notifications in southern Scotland are as follows: v.c.72 (1934), v.c.73 (1946), v.c.74 (1959), v.c.75 (1961), v.c.76 (1941), v.c.77 (1953), v.c.78 (1957), v.c.79 (1958), v.c.80 (1949), v.c.81 (1957) (data from Census M.S.). In northern Scotland records are still wanting from Ross East and Sutherland East, although the species has colonized freshwaters in the Orkneys and Shetlands.

Bithynia tentaculata (Linné) (1). Loch Heron, v.c.74 (25/2765).

Carychium minimum Müller (40), *C. tridentatum* (Risso) (73). The relative scarcity of *Carychium* is probably an indication of the general lack of lime.

Physa fontinalis (Linné) (4). Surprisingly rare, and found only in v.c.s 74 and *75 (25/05, 25/26, and in the River Irvine in 26/33 and 26/43).

Planorbis carinatus Müller (1). River Irvine, *v.c.75 (26/3837), and Coodham House lake, *v.c.75 (26/3932).

Planorbis laevis Alder (1). Glenbuck Loch, *v.c.75 and *v.c.77 (26/7528). Associated with *Potamopyrgus jenkinsi, Lymnaea peregra, Planorbis albus, Ancylus fluviatilis,* and *Sphaerium corneum.*

Planorbis crista (Linné) (2). Ayr, *v.c.75 (lake, 26/3720); Calzeat, v.c.78 (pond, 36/1134).

Segmentina complanata (Linné) (1). River Irvine, *v.c.75 (26/4637).

Acroloxus lacustris (Linné) (1). Belston Loch, *v.c.75 (26/4716).

Succinea oblonga Draparnaud (1). Found living in damp muddy patches with a sparse grassy vegetation on the floodplain of the River Irvine near Kilmarnock, v.c.75 (26/467377), a habitat typical for this rare species in Scotland (Kevan, 1931).

Succinea putris (Linné) (4), *S. pfeifferi* Rossmässler (34). The former species appears to reach its northern limit in the British Isles in the extreme south-west of Scotland (records confirmed by dissection exist only for v.c.s 72, 73 and 79). Most of the older records from elsewhere probably refer to globose forms of *S. pfeifferi.*

Cochlicopa lubrica (Müller) (120), *C. lubricella* (Porro) (31). The latter is sporadic across the whole area, usually in drier habitats.

Columella spp. (43). Both *C. edentula* (Draparnaud) and *C. aspera* Waldén are fairly widespread. Material collected during the expedition is being segregated by Dr. Paul.

Vertigo pusilla Müller (2). Sieved from among ivy on stone walls near Kirkmichael, v.c.75 (26/355082), and near Dalrymple, v.c.75 (26/379137).

Vertigo substriata (Jeffreys) (8). Unexpectedly rare, in contrast to its frequency in similar non-calcareous highland areas in Wales and Ireland (Kerney, 1973).

Vertigo lilljeborgi Westerlund (2). The standard paper on the distribution and ecology of this subarctic species in Scotland was published some forty years ago (Kevan and Waterston, 1933). On the present expedition two new sites were discovered: at Loch Heron, v.c. 74 (25/272652), and at Loch of the Lowes, *v.c.79 (36/233192). At Loch Heron *V. lilljeborgi* lives with *V. antivertigo* in wet moss in a narrow band of *Juncus* fringing the shore. At Loch of the Lowes the habitat is a *Juncus* marsh rich in liverworts and mosses. *V. lilljeborgi* was particularly common under dead liverwort thalli, associated with *Lymnaea truncatula* and *Euconulus fulvus alderi;* no other species of *Vertigo* was present here. A common feature of the two sites, apparently shared by most of the other known stations in Britain, including the unique recently discovered Welsh site (Dance, 1972), is that the habitat is subject to periodic deep flooding. Conversely, the species seems to be unknown from fens with a stable water level.

Lauria cylindracea (da Costa) (75). Relatively local, especially in upland areas above 1,000 ft.

Lauria anglica (Wood) (4). Rare, Kirklinton, v.c.70 (mixed deciduous wood, 35/434688); Glenluce, v.c.74 (mixed deciduous wood, 25/191574); Croy Brae, v.c.75 (mixed deciduous wood, 26/256132); Kirkmichael, v.c.75 (marshy floodplain under beech, 26/344079).

Acanthinula lamellata (Jeffreys) (16). The classic species of old woodland. Geological evidence shows it to have receded northwards and westwards from a much wider distribution within the British Isles at the time of the Postglacial forest optimum. The typical habitat in this area is in moist shaded deciduous

woods, characteristically in drifts of leaf litter among clumps of *Luzula*. The species is tolerant of neutral to acid soils, and is sometimes associated with *Zonitoides excavatus*. Many sites show management and planting, but the habitats nevertheless probably represent a continuity of forest growth from the primary woodland of the earlier Postglacial.

The detected sites are as follows:

v.c.70. Kirklinton (mixed deciduous wood, 35/434688).

v.c.72. Drumlanrig (mixed deciduous wood, 26/861030); Eaglesfield (mixed deciduous wood, 35/249748); Canonbie (mixed deciduous wood, 35/387782); Penton (hazel coppice, 35/431773).

v.c.73. Glen Trool Lodge (deciduous/coniferous wood, 25/406802).

*v.c.74. Glenluce (mixed deciduous wood, 25/191574).

v.c.75. Pinwherry (hazel coppice, 25/195884); Barrhill (beech wood, 25/223822); St. Quivox (mixed deciduous wood with *Rhododendron* 26/387230); Failford (beech wood, 26/462262); Kilmarnock (beech wood, 26/463327); Wallaceton (beech wood, 26/602217).

*v.c.76. Majeston (oak/ash wood, 26/234724).

*v.c.77. Yonderton (mixed deciduous wood, 26/797369).

*v.c.80. Jedburgh (beech wood, 36/639182).

Vallonia pulchella (Müller) (1), *V. excentrica* Sterki (7). A rare genus everywhere in the highland zone of Britain.

Ena obscura (Müller) (2). v.c.80 only (36/52, 36/72). An eastern species in Scotland.

Clausilia dubia Draparnaud (2). Penton, v.c.70 (bridge walls, 35/432774); Castleton, v.c.80 (old graveyard wall, 35/508898). A rather small form is common at both places. These colonies must be regarded as outposts of the main area of distribution of the species across the Border in the northern counties of England.

Helix aspersa Müller (6). Only in coastal sites in Wigton and Ayr, with the exception of a colony at Knockaughley, v.c.72 (wall by garden, 25/728915). An old record (1891) from Moffat, v.c.72, could not be confirmed.

Hygromia subrufescens (Miller) (35). Widespread in woods and damp roadbanks.

Hygromia striolata (Pfeiffer) (65). Doubtless introduced by man. Common in disturbed sites, such as around farm buildings.

Monacha granulata (Alder) (15). Very common within a rather sharply defined area in Roxburgh and Selkirk (36/30, 31, 32, 40, 41, 50, 51, 52, 61, 62, 72, 73). Also seen in 26/26, and in 35/37 and 38.

Helicella caperata (Montagu) (2). Dry roadbanks near Stewarton, v.c.75 (26/443442) and Yetholm, v.c.80 (36/815268).

Discus rotundatus (Müller) (121). Difficult to find in a few of the bleakest mountain areas, where it shows signs of being anthropophilic.

Arion hortensis form "B" (12). The taxonomy of this rather distinct slug, only recently recognized in Britain and Ireland, requires further elucidation (see

Davies, 1972). Colonies were detected sporadically right across the area.

Euconulus fulvus (Müller) (73). The segregate form *E. fulvus alderi* (Gray) is much less common than *E. fulvus fulvus*.

Oxychilus draparnaldi (Beck) (2) Maybole, *v.c.75 (cemetery wall 26/305096); Houston, v.c.76 (wall, 26/412661).

Zonitoides excavatus (Alder) (8). Surprisingly uncommon, in view of the prevalence of non-calcareous soils, and the known frequency of the species in some other parts of Scotland.

Zonitoides nitidus (Müller) (2). Curiously absent from most marshes. Loch Heron, v.c.74 (25/2765), and Yetholm Loch, v.c.80 (36/8028).

Milax sowerbyi (Férussac) (1), *M. budapestensis* (Hazay) (8). (*M. gagates* was nowhere seen). These "garden" slugs were doubtless under-recorded, but nevertheless by English standards must be scarce in the Southern Uplands. *Milax* is said to be frequent in waste ground and gardens around Glasgow (Dobson, 1963).

Limax cinereoniger Wolf (2). Found in old mixed deciduous woods at Drumlanrig, *v.c.72 (25/862032) and Yonderton, *v.c.77 (26/798367), in each case associated with *Acanthinula lamellata*.

Limax flavus Linné (1). Seen active at night in great abundance on a stone wall in Moffat, *v.c.72 (36/075053).

Agriolimax agrestis (Linné) (35). Although detected in the Hebrides by Mr. A. R. Waterston as early at 1933, it has only recently become evident that this north European species is widespread in Scotland, and is locally as common as the nearly ubiquitous *A. reticulatus* (Müller) (Kellock, 1970). Most of our own records were checked by dissection by Mr. Norris, confirming that it is usually possible to identify this species on field characters alone. In the Southern Uplands *A. agrestis* is most frequent in the wilder hill areas. It tends to prefer damper habitats than *A. reticulatus* and is often found on the floodplains of streams. The stems of *Umbelliferae* on lush grass road verges are also a characteristic habitat. Dr. H. W. Waldén informs me that he found the species frequently in similar situations in Perthshire in August 1973.

Agriolimax caruanae Pollonera (32). Mainly in west, and usually showing a clear association with human rubbish. Perhaps a recent introduction.

Sphaerium lacustre (Müller) (1). Near Dalrymple, *v.c.75 (stagnant pond, 26/372134).

Pisidium spp. Owing to difficulties of collection the genus is under-recorded. The following figures probably reflect fairly well the relative frequencies of the different species within the area, except that *P. lilljeborgii* no doubt occurs in many more mountain lochs, not easily accessible during a rapid survey: *P. casertanum* (Poli) (39), *P. personatum* Malm, (33), *P. subtruncatum* Malm (32), *P. nitidum* Jenyns (30), *P. hibernicum* Westerlund (12), *P. milium* Held (9), *P. amnicum* (Müller) (5), P. *lilljeborgii* Clessin (3), *P. obtusale* (Lamarck) (1) *P. pulchellum* Jenyns (1).

Pisidium lilljeborgii Clessin (3). Loch Doon, v.c.75 (25/485951 and 26/479017); Loch Nahinie, v.c.75 (25/277772).

Pisidium pulchellum Jenyns (1). Abundant and finely developed in Belston Loch, *v.c.75 (26/4716), associated with much smaller numbers of *P. subtruncatum* and *P. nitidum*.

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ATAGEMA GIBBA PRUVOT-FOL, A DORIDACEAN NUDIBRANCH NEW TO THE BRITISH FAUNA

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(*Read before the Society, 16 March 1974*)

INTRODUCTION

On 24 November 1973 a Bristol aqualung diver, Mr. Bernard Picton, obtained a brownish dorid nudibranch from a rock lying in the sea at 12m depth off Porthkerris Point, Cornwall. The specimen was kept alive for several weeks in the Bristol Zoology Department Aquarium. It proved to be the first British record of an imperfectly described Mediterranean species *Atagema gibba* Pruvot-Fol, 1951.

DESCRIPTION

External features. The length overall when extended was 68mm but when at rest the body contracted to only 40 mm, and the ample mantle skirt accordingly became wrinkled and crenulated. Certain of these crenulations persisted permanently even when the specimen was actively creeping (Fig. 1). The General aspect of the body was rather flattened, like a *Discodoris*, but a conspicuous elevated zig-zag dorsal pallial ridge was present, from between the rhinophores to the branchial pocket (Fig. 1, 2D). This mid-dorsal ridge was especially strong immediately anterior to the branchial area and formed a gross hump-like excrescence. This hump was more obvious on some occasions than others, although the dorsal ridge itself was always conspicuous, even after preservation.

The dorsal mantle surface felt stiff and velvety to the human touch. It was covered with small digitiform spiculose tubercles (Fig. 2C) which were not uniformly distributed but formed a pattern of papillose anastomosing strands surrounding smooth areas (Fig. 2B). The papillae were whitish while the smooth areas were dark brown. Papillae predominated in areas of the mantle near the median dorsal line, while smooth brown areas predominated nearer to the mantle edge. In this way the characteristic pattern is produced (Fig. 1). The trumpet-shaped rhinophore sheaths bore numerous tubercles and encircled the mottled brown and white rhinophoral tentacles (Fig. 1F). Each rhinophore bore 19 or 20 lamellae.

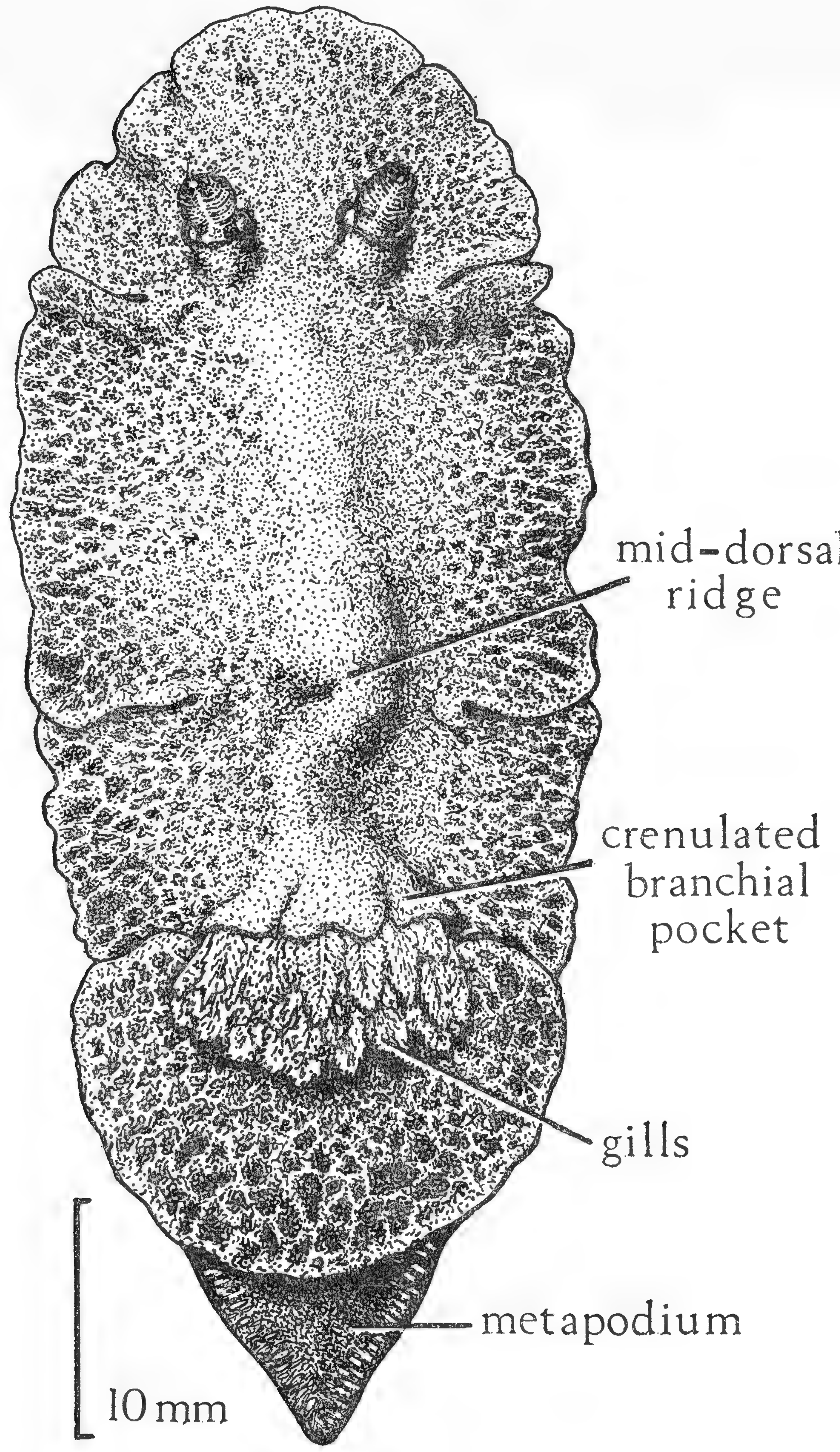

Fig. 1. *Atagema gibba,* from the dorsal aspect.

The branchial pocket had a crenulated rim which formed 5 flanges, each overlying a voluminous gill plume. The gills were mottled brown and white, tripinnate or quadripinnate, and were directed posteriorly rather than dorsally (contrary to all the other British cryptobranchiate dorids).

The underside of the mantle was mottled brown and white while the pedal sole was a more uniform pale brown (Fig. 2E). The propodium was transversely

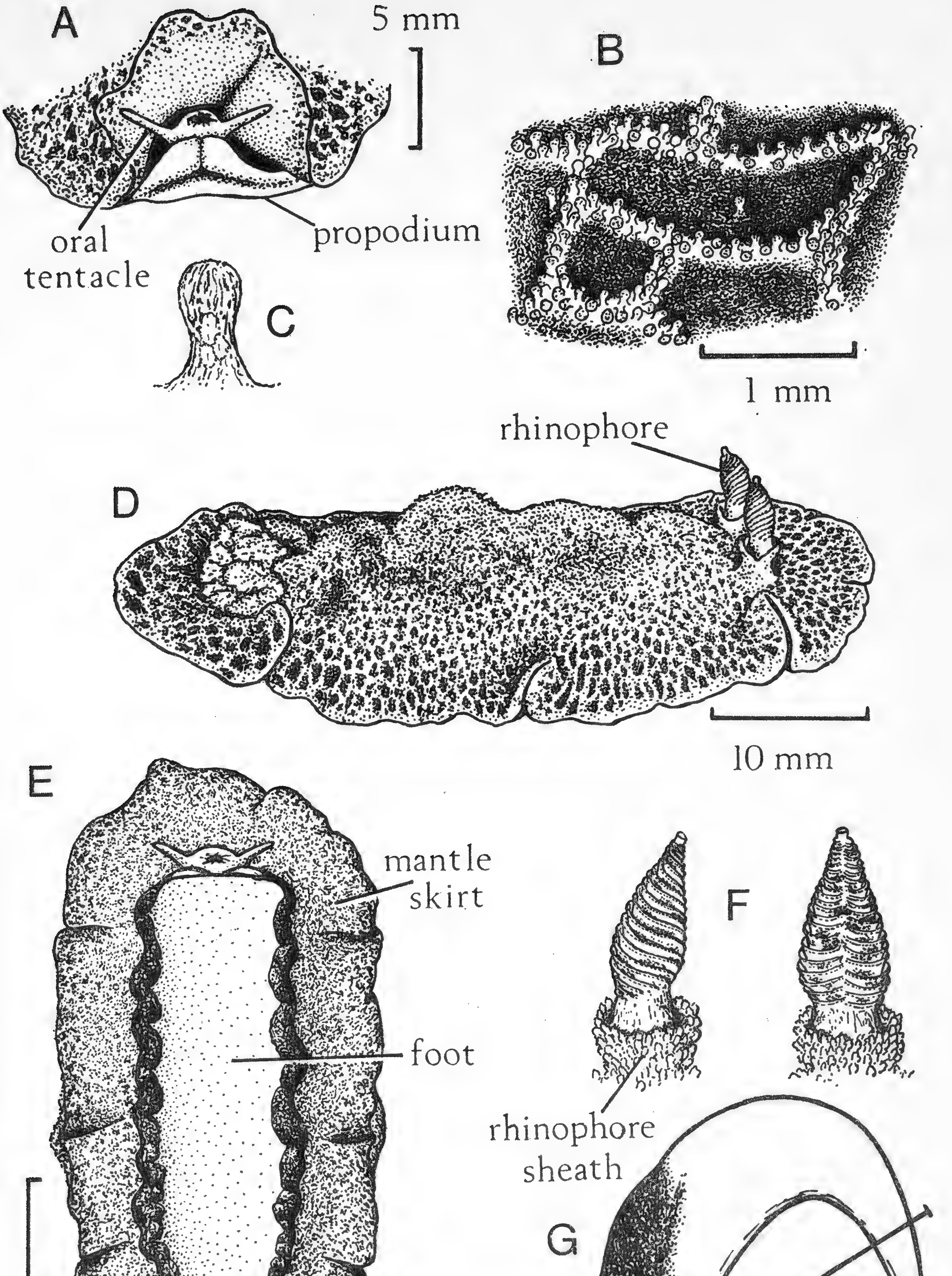

Fig. 2. *Atagema gibba* A, anterior view of the head, with the mantle skirt raised. B, part of the dorsal mantle. C, single mantle papilla. D, lateral view of creeping specimen. E, ventral view. F, side and front views of a single rhinophore. G, single representative radula tooth.

grooved and notched in the mid-line anteriorly. The head bore a pair of digitiform oral tentacles (Fig. 2A).

Anatomy. Paired systems of gill retractor and buccal mass retractor muscles were conspicuous and a substantial blood gland overlying the ganglia of the central nervous system was also obvious. Elongated strap-like salivary glands (a pair) reach back from the buccal mass to the stomach, passing, like the foregut, through the ganglionic ring. The stomach was largely free from the digestive gland, and possessed a small but distinct gastric caecum projecting ventrally. The ovotestis overlay the digestive gland and contained abundant apparently mature orange-coloured oocytes. The anterior genital mass was similarly well developed. The penis was long and slender and bore no armature.

These features, evident after gross dissection, show that *Atagema* resembles *Archidoris* fairly closely. The radula was removed and examined microscopically and this too showed close correspondence. The formula was 23 x 30·0·30. Each tooth had a dark brown base and a smooth erect hook-like cusp (Fig. 2G). In each tooth row the components are smaller near the mid-line and near the periphery. The radular teeth differ from those of *Archidoris* chiefly in the dense pigmentation of the relatively small basal attachment zone.

DISCUSSION

There are 3 known species of *Atagema* in the north Atlantic Ocean: *Atagema rugosa* Pruvot-Fol, 1951 (single specimen from Banyuls-sur-Mer), *A. gibba* Pruvot-Fol, 1951 (two specimens from Banyuls-sur-Mer), and *A. africana* Pruvot-Fol, 1953 (single specimen from Dakar, N. Africa). Later Pruvot-Fol (1954) recorded a dubious specimen in the collection of the Roscoff Biological Laboratories and was unable to do more than give it the generic name *Atagema*.

There can be little doubt that the Porthkerris specimen corresponds in most particulars with Pruvot-Fol's *A. gibba*, although the original description was gravely defective in that no mention was made of dimensions (other than "plus grand que. *A. rugosa*"), colour (other than "brune . . . avec . . . taches presques noires"), date of collection, depth (or other ecological characteristics), nor anatomy.

It is clear that the genus *Atagema* Gray, 1850 (type *Doris carinata* Quoy & Gaimard, 1832 : New Zealand) embraces also *Petelodoris* Bergh, 1882 (type *P. triphylla* Bergh, 1882 : Japan) and *Sclerodoris* Eliot, 1904 (type *Doris osseosa* Kelaart, 1859). In this wide sense it can be seen that *Atagema* is principally a tropical Indo-Pacific genus. Certainly the Porthkerris specimen presented a distinctly tropical aspect, being flattened like a *Discodoris,* with elaborate branchial and rhinophoral protective devices and a rapidity of response and retraction unusual in the customary British doridaceans.

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Conch. 28: 239–242 (1974)

DISTRIBUTION MAPS OF *HELIX POMATIA* L.

E. Pollard

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(*Read before the Society, 20 April 1974*)

In 1971 a study of the population ecology of *Helix pomatia* L. was begun in Cambridgeshire. In the course of this work information has been acquired on the general biology and distribution of the species in Britain. Information on distribution was already available through the Conchological Society's 10-kilometre square mapping scheme (Kerney, 1967) and the new information has supplemented this.

The 241 records for *Helix pomatia* in the mapping scheme (excluding those added by this work) were used to produce a map (Fig. 1) based on presence or absence in 10-km squares. Pre-1960 records are distinguished from 1950 and later records. The species occurs mainly on chalk on the North Downs and in Hertfordshire and on limestone in the Cotswolds.

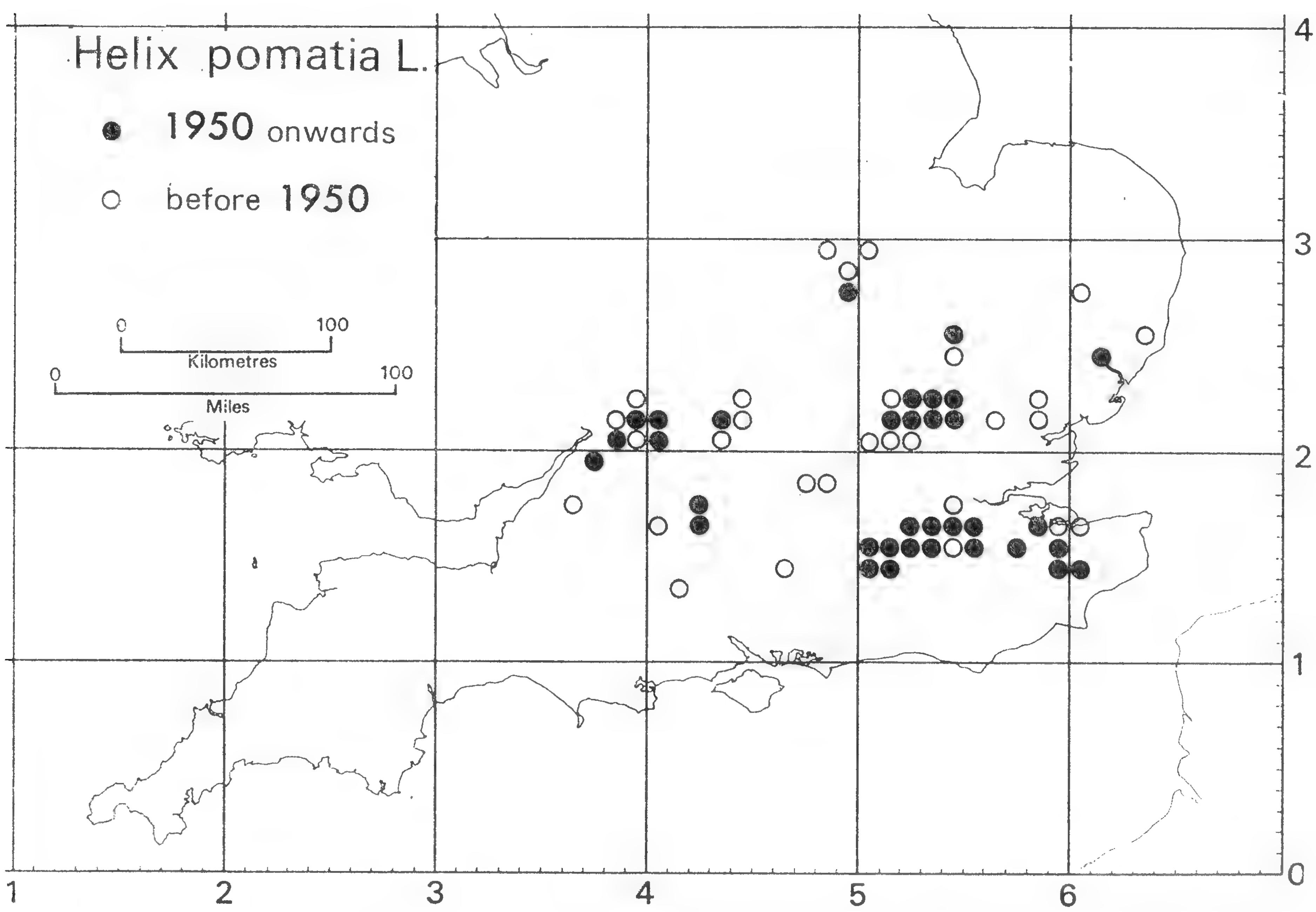

Fig. 1. Distribution of *Helix pomatia*, from records contributed to the 10-kilometre square mapping scheme, excluding those obtained by the author.

A further 186 records have been added during this research project from a variety of sources; additional literature records, requests for information from regional officers of the Nature Conservancy Council, a large number from Professor J. Z. Young, who has been recording the distribution of the species for a number of years, from members of the public who visited an exhibit on *Helix pomatia* which was part of Monks Wood Open Week in 1973, and also from a variety of other miscellaneous sources. Fig. 2 shows the map produced by combining these records with those of the Conchological Society. Of the 186 additional records, 171 (91·9%) were in 10-kilometre squares, where *H. pomatia* was already recorded, while 15 (8·1%) were in new ten 10-kilometre squares. In addition a few squares previously with old records only were recorded as 1950 or later.

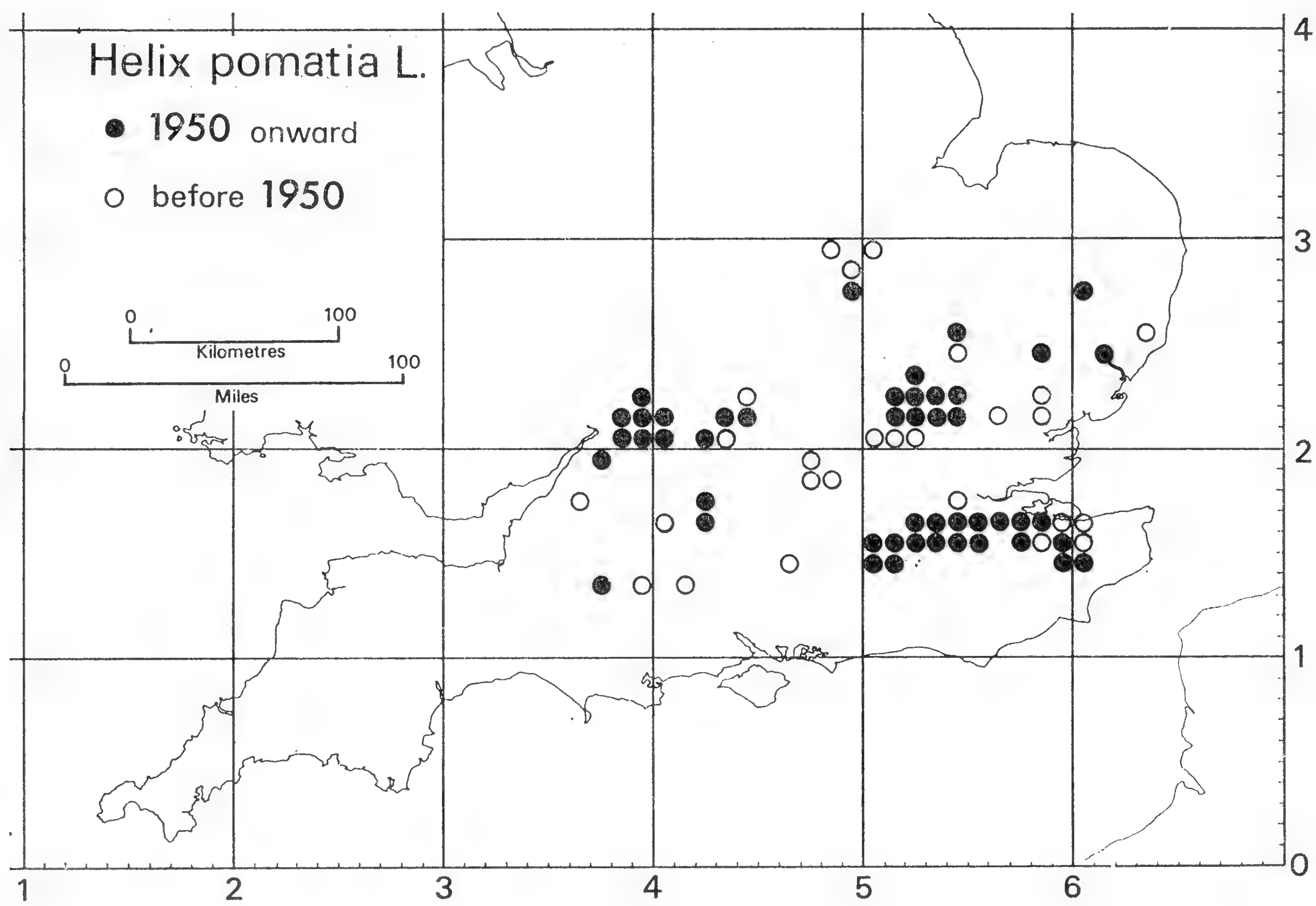

Fig. 2. Distribution of *Helix pomatia*, from records obtained by the author from a variety of sources, in addition to those contributed to the mapping scheme.

There is no doubt that the distribution of *Helix pomatia* is better known than that of any other British land or freshwater mollusc of comparable status. If we look at the number of sites known in each 10-kilometre square (Fig. 3) we find, as might be expected, that the new squares added are those in which the species is rare. All of the squares with five or more sites known were recorded by the mapping scheme. When a species is as thoroughly mapped as this the presence or absence system of mapping no longer provides a very good impres-

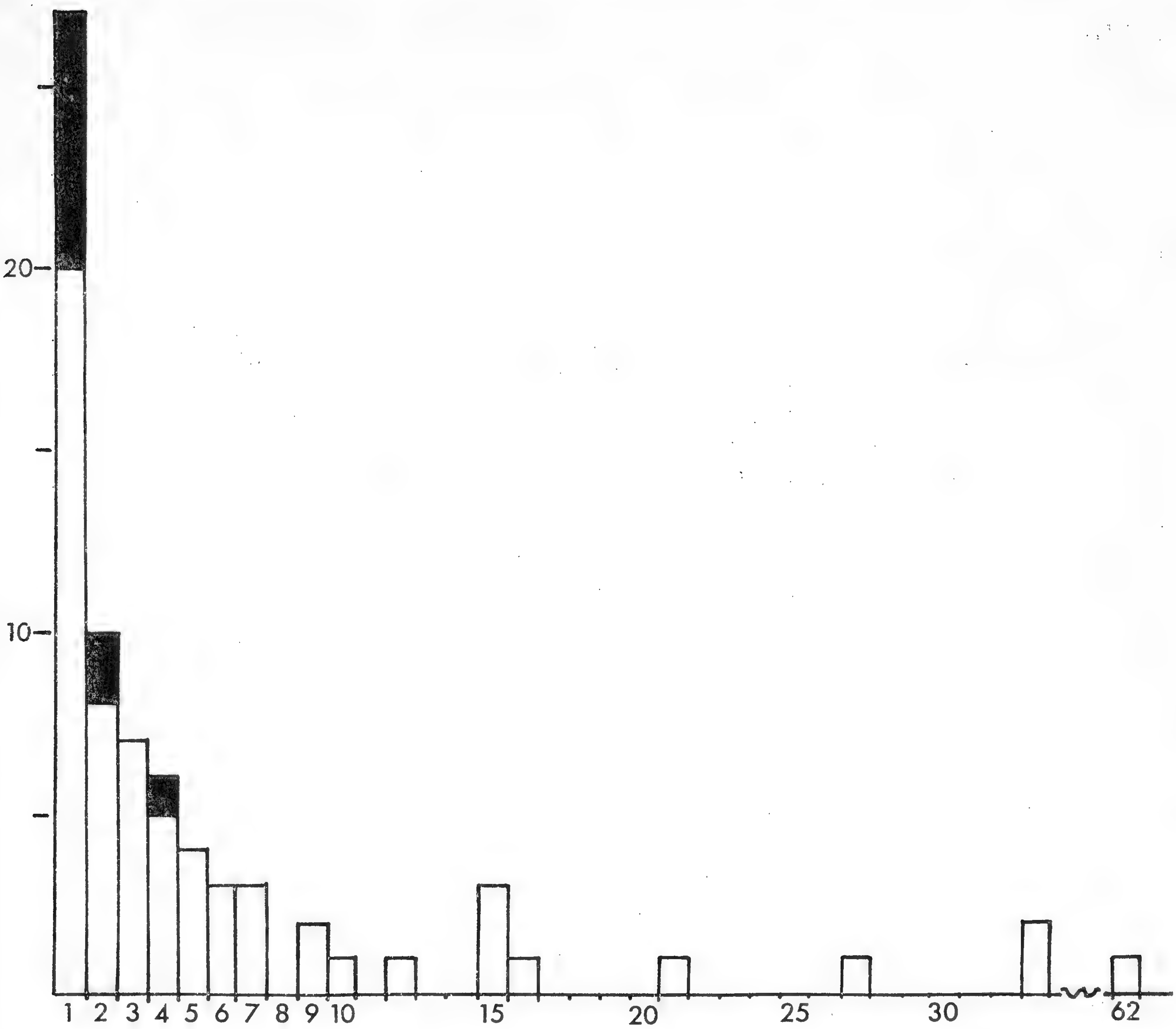

Fig. 3. Histogram showing numbers of 10-kilometre squares with 1 site, 2 sites, 3 sites and so on. Open columns, squares recorded by the mapping scheme; closed columns, squares added by the author's records.

sion of the distribution. A large proportion of the squares have very few records and the true centres of distribution are lost. In this case 37 of the 73 squares have only one or two sites recorded.

One way to present a map to show the distribution of a thoroughly recorded species such as this is to base it on the number of sites per 10-kilometre square (Fig. 4). The number of sites was judged by inspection of the records for each square. Where no details of the exact locality were given each record was taken to be a separate site. Where two or more records clearly referred to the same site, either by names or by precise grid reference, then they were recorded as one site. Here the centres of distribution are clearly shown. No attempt has been made here to separate old and new records.

It is unlikely that any other land snail, apart from those with very restricted distributions, will be recorded as thoroughly as *Helix pomatia* for many years,

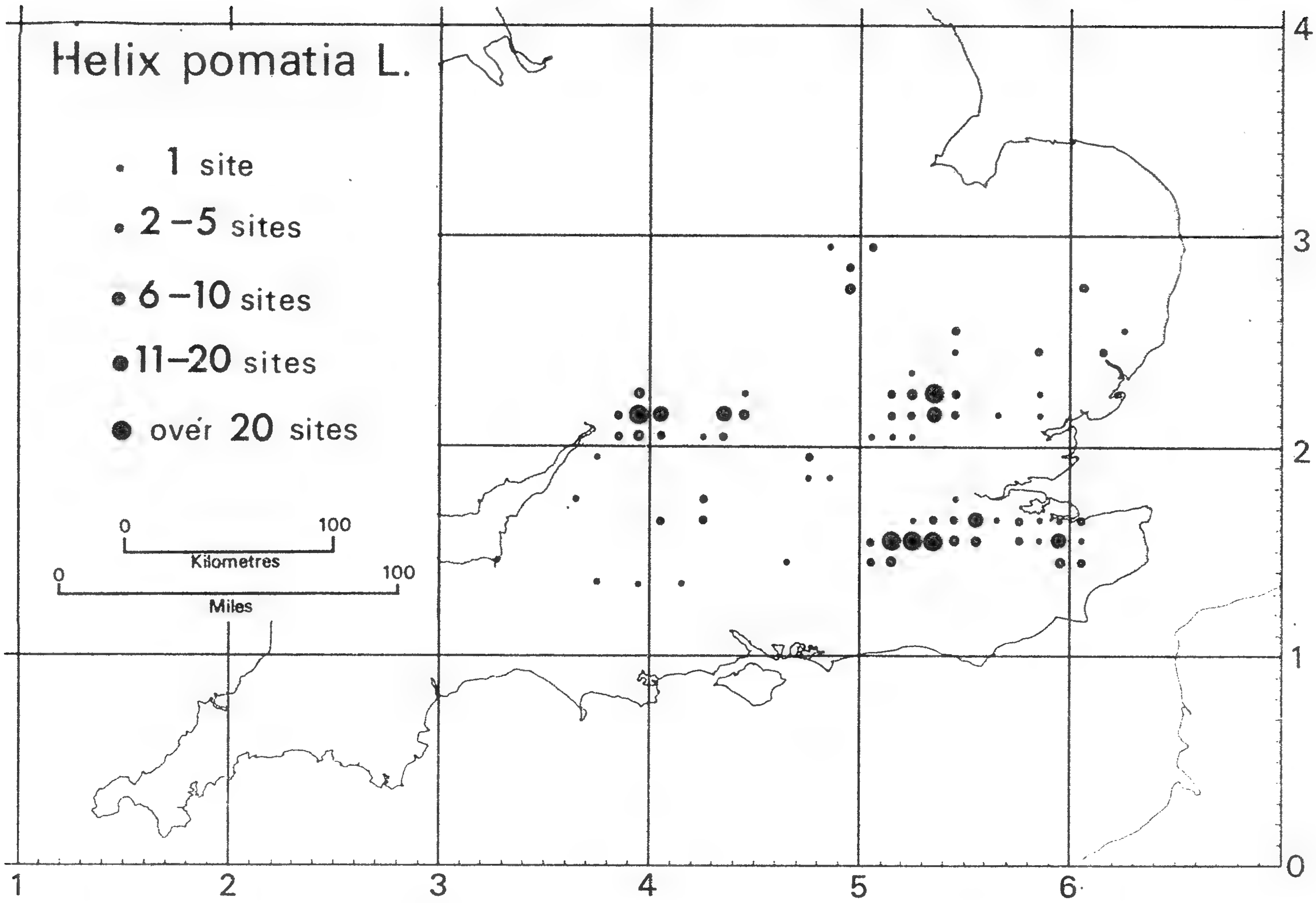

Fig. 4. Distribution of *Helix pomatia* showing density of recorded sites per 10-kilometre square.

so that this type of map is unlikely to have a wide use. However it is possible that similar maps could be produced for other groups of plants and animals—where the distributions are well known and further mapping is not adding many new squares to conventional distribution maps.

I would like to thank Dr. M. P. Kerney for permission to use records from the Conchological Society's mapping scheme, all the people who kindly supplied me with informaiton on the distribution of *Helix pomatia,* and Mrs. J. M. Welch who has been responsible for the organisation of the distribution data and the production of the figures.

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J. Conch 28: 243–245 (1974)

AN ENERGY BUDGET FOR *AGRIOLIMAX RETICULATUS* (MÜLLER) ON GRASSLAND

D. Pallant

Brune Park School, Gosport, Hampshire and the Department of Biology, University of York.

(*Read before the Society, 18 May 1974*)

Ecological energetics, the consideration of the energy relationships within communities and habitats, has become of increasing importance to the understanding of ecology in recent years. There have however been few studies of molluscan ecology in these terms. Newell (1967) summarises studies up to that time and indicates the scarcity of knowledge in this field. Stern (1969) studied *Arion ater rufus* (L.) in laboratory growth experiments and Mason (1970) studied populations, feeding rates and assimilation in woodland snails. The present note establishes an energy budget for the grey field slug, *Agriolimax reticulatus* (Müller) from a combination of laboratory and field studies concerned with rough permanent pasture, Westwood, Beverley, Yorkshire (Nat. Grid Ref. 54/026387). The floral structure of this site has been briefly described elsewhere (Pallant, 1972).

Surface active populations of *A. reticulatus* were sampled over a period of one year at approximately monthly intervals using baited refuge traps. Quadrat and grass tuft surveys previously reported (Pallant, 1974a) were contemporary with some of the trapped samples and were used to convert the latter to population estimates per m^2. The trapped slugs were all weighed and the mean weight per sample is used in table 1 to establish the wet weight biomass from the estimated population. Wet weight to dry weight conversion factors and total body energy had previously been determined in the laboratory (Pallant, 1974b). From these the dry weight and energy biomass figures of table 1 were estimated. Thus estimates are produced of the population per m^2 in terms of numbers, weights and energy content of the animals. The average, or arithmetic mean, of each of the columns of table 1 gives a mean standing crop (average numbers of animals per m^2) of *A. reticulatus* per year which forms the basis of the estimates of table 2.

An animal exchanges energy with the environment as intake of food and output of faeces, exuviae, secretions, excreta and heat. All of these can be assessed as calories, or kilocalories (i.e. 1000 calories) where more appropriate, to avoid unduly large numbers. Laboratory studies (Pallant, 1974b) were used

TABLE 1

Population and biomass estimates of *A. reticulatus* on rough pasture, Westwood, Beverley, Yorks.

Year	Month	Population per m^2	Biomass: wet weight (mg/m^2)	dry weight (mg/m^2)	energy (Calories/m^2)
1968	November	4·34	1077·62	130·93	662·50
	December	14·76	2262·71	247·92	1254·47
1969	January	9·11	1723·61	209·42	1059·66
	Feb./March	9·11	1249·89	151·86	768·41
	Apr./May	16·06	2445·94	297·18	1503·73
	May	5·64	1244·75	151·24	765·27
	June	4·77	822·35	99·91	505·54
	July	16·06	2237·16	271·81	1375·36
	September	6·08	940·58	114·28	578·26
	October	8·25	1263·90	153·56	777·01
	November	0	–	–	–
	December	0	–	–	–
	MEANS	7·85	1272·37	154·59	782·22

TABLE 2

Energy budget for *A. reticulatus* on rough pasture, Westwood, Beverley, Yorkshire, per m^2 per year.

Mean standing crop:	
Number of animals	7·85
Energy (calories)	782·22
Food:	
Ingested (kilogram calories)	28·23
Defaecated (kilogram calories)	6·49
Assimilated (kilogram calories)	21·74
Respired (kilogram calories)	9·06
Production (kilogram calories)	12·68

to determine the proportion of the food ingested which was assimilated, i.e. the assimilation ratio, from the quantity of faeces produced from a known amount of food eaten. These figures also allow estimation of the amount of food eaten and the amount assimilated in twenty four hours in the field when faeces produced in twenty four hours after capture are determined. An assimilation ratio of 0·77 was found in laboratory experiments i.e., 77% of the food which this animal eats is assimilated into its body and metabolised. The quantity of food assimilated per 24 hours per 100 mg dry weight of animal was found to be 38·53 calories. The laboratory experiments also allowed a determination of the proportion of the food assimilated which was used for the growth of the animal, i.e. the net growth efficiency, the mean value of which was 58·31%. The estimates in table 2 of the amount of energy respired are derived as the difference between the amount of food assimilated and the amount used for growth. Thus

other exchanges of energy with the environment are ignored. If the respiration estimate is based on laboratory respirometry (Newell, 1967) a lower figure is obtained viz. 5·53 kilocalories per year and the difference between the two figures can perhaps be assumed to represent these other exchanges with the environment. The present estimates ignore production of eggs and underestimates very small animals, as these were not satisfactorily trapped or otherwise estimated. It is possible that considerable amounts of energy are passed out of the animals as mucus. Thus the "production" element of table 2 is likely to be an underestimate, since it is taken only from estimates of energy used in the growth of surviving large animals.

Thus as a first crude estimate of the energy exchanges beween *A. reticulatus* and the rough grassland studied it seems that on average over the year there will be 7·85 animals on each m^2 and these will contain materials with an energy value of 782·2 calories. In one year the animals of this species on each square metre of the grassland will eat plant material, mostly grasses, containing 28·23 kilocalories and defaecate 6·49 kilocalories, thus assimilating for their use matter containing 21.74 kilocalories. About 58% of the food assimilated will be incorporated in the animals in growth and about 42% of it will be respired.

ACKNOWLEDGEMENTS

I am grateful to the Royal Society Committee for Scientific Research in Schools for their support and to Professor M. H. Williamson for his advice and encouragement.

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J. Conch. *28*: 246 (1974)

REVIEW

Die miozäne Molluskenfauna von Miste-Winterswijk NL (*Hemmoor*). By Fritz Nordsieck. Gustav Fischer Verlag, Stuttgart. 1973. Price 118DM.

The fauna described comes from the Hemmoor stage of the Miocene at a locality in the Netherlands close to the border with Germany. The site was discovered by Mr. Kolstee, an amateur geologist living at Winterswijk, and subsequently excavated by a group of amateurs. Five kilograms of sieved material were purchased from this group and the Mollusca from this sample are described systematically. Fortunately the layout of the book is not quite as complicated and difficult to use as the same author's works on recent European molluscs but a considerable amount of referring backwards and forwards is still necessary. Personally I have never seen a simpler system than plate and figure numbers with the plate description (including page numbers for the description) adjacent to the plate. For such an expensive book one could have hoped for a better standard of illustration. The line drawings of gastropods are frequently good but many of the bivalves are poorly drawn.

Several new species, genera and subgenera are described from very inadequate material. For example, among the gastropods, a small new genus *Nisaclis* is described from internal casts only. Two new species of this genus are given, *N. compressa* based on two casts and *N. convexa* based on a single fragmentary cast. The descriptions of new species are very inadequate and their relations to closely related species are scarcely discussed; type material is not designated. As a result most of the new species and genera are not accepted by many other European workers.

As a malacologist used to dealing with living material the author has brought a fresh viewpoint to this study and it is a pity that the work was not more thorough and that other collections from the same site were not studied.

P. G. Cambridge

J. CONCH. *28*: 247–248 (1974)

REVIEW

Freshwater snails of Taiwan (*Formosa*). By Gary L. Pace. Malacological Reviews, Supplement 1. 118pp., 19pls. 17 text-figs. 1973. Price US $15.00.

Over the last thirty years or so Dr. Henry van der Schalie has built up a research team at the University of Michigan primarily interested in the role of molluscs as vectors of parasites. Dr. van der Schalie has rightly insisted that parasitologists cannot hope to solve their problems without knowledge of the basic biology of the mollusc hosts. A very considerable 'spin-off' of malacological information, particularly relating to freshwater molluscs of tropical regions, has resulted and Pace's report is just such a work.

Brief summaries of the geology, climate, soils and vegetation are followed by an historical review of collections from Taiwan and a succinct account of the research methods. The main body of the work is the systematic section illustrated with Mr. Tottenham's superb line drawings of the shells and the author's equally fine camera lucida drawings of anatomy and radulae. Compact distribution maps are given for most species and for the principal human parasitic diseases. Three plates of photographs do not quite match the standard of the drawings but are adequate for their purposes.

The systematic section begins with a lengthy key which uses both anatomical and shell characters. The key is largely rendered unnecessary by the excellent illustrations. Any parasitologist using the work will identify his snails much more quickly from the illustrations than from the key. Much information not usually found in identification handbooks is included. The widespread occurrence of many species (particularly neritids and thiarids) and the lengthy lists of potential synonyms indicate that comparative studies of Indo-Pacific freshwater molluscs are still urgently needed.

A summary section discusses habitats, zoogeographic affinities and parasitology. Neritids and thiarids are largely Indo-Pacific. Pace comments that their wide salinity tolerances and reproductive strategies have probably contributed to their widespread occurrence. The other families are largely of mainland origin while four species are endemic to Taiwan.

The discussion of parasitology is depressing to anyone interested in combating disease. Local feeding habits probably account for the occurrence of Clonorchiasis in southern Taiwan. Intermediate hosts, *Corbicula, Anodonta* and *Cipangopaludina chinensis* (once *Bellamya malleata*), are sold in Tai Pei fish market and often eaten raw. Despite the widespread occurrence of both infected swine and the intermediate host, *Sementina hemisphaerula,* human infection with Fasciolopsiasis is confined to two small areas where people eat water caltrop raw, peeling the nuts with their teeth. Prevention is ludicrously simple: the incidence of human infection decreases away from the water plantations probably because drying during transport kills the parasite metacercariae. Simply eating

dry nuts should eradicate the disease! I wonder if the wide salinity tolerance of neritids accounts for their high degree of immunity to parasites? A detailed list of collecting sites and an extensive reference list conclude the paper.

The style is lucid although the difficulty of maintaining a fresh approach in discussing distribution and synonymies has led the author into several awkward or ungrammatical sentences. Personal pronouns require antecedents and the use of "Ibid." in quoting references is undesirable. Together they become dangerously misleading in sentences such as: "This form (Ibid., pl. 112, fig. 120) is very close to one of his figures (Ibid., pl. 109, fig. 23) of *Neritina communis* Quoy & Gaimard (= *N. waigiensis Lesson*). In fact, in his description (Ibid., p. 538) he remarked about its similarity to this extremely variable species." (p. 20). The reader has to go back *three sentences* to find that "he" is Sowerby (1855), and pass references to Hirase & Taki (1951) and Habe (1964a) on the way. The meaning is in fact clear in the context, *but only just.* The author (and editor) do not realise that "none" is singular in English. Other mistakes and misprints are rare and do not detract from the overall excellence of Pace's work. I found *Clonochis* for *Clonorchis* (p. 38), *striatissma* for *striatissima* (p. 60) and was amused to learn that "the verge [i.e. penis] is carried under the right tentacle of the female" (!) in *Neritina, Theodoxus, Septaria* and *Neritodryas* (p. 13).

This is a paper for professional malacologists, parasitologists and biomedical researchers interested in Far East non-marine molluscs and I wholeheartedly recommend it to them. It is not a guide for shell collectors although a very useful aid to identification and full of fascinating information on the snails and their effects on other organisms. The price is quite ridiculous, but in a few years it will probably seem a bargain.

CRCP

J. CONCH. 28: 249 (1974)

REVIEW

Key to the British Marine Gastropods by Shelagh M. Smith. Royal Scottish Museum, Information Series Natural History. 43pp., 42 line drawings in 4 figs. 1974. Gratis.

This key is entirely artificial and is intended solely as an aid to the identification of the British marine Gastropoda. The nomenclature follows that of the Concordance to the field card for British marine Mollusca and therefore is identical to that used on the Field Cards issued by the Conchological Society. For those species with shells, the key is based on shell characters only and is easy to follow, the figures being of great help in making difficult terms clearer, i.e. the difference between reticulate and tuberculate ornamentation etc.

The author has based the key on dichotomous principles although with such large groups she has had to adapt it occasionally, making it at times slightly more difficult than a straightforward dichotomy. It is helpfully divided into twenty main sub-sections but the most useful parts of the whole work are the keys to the four groups that Dr. Smith has selected for special attention: the Trochidae, Rissoidae, Pyramidellidae and Pteropoda. The Rissoidae and Pyramidellidae have been major stumbling blocks to many an amateur and professional and both these groups have been expertly treated. Any attempt at keying these families is a major task and the author must be given full credit for her excellent work, although it is a pity that these difficult species could not have been illustrated. It is also a pity that the key on the nudibranchs is so inadequate, leaving the conchologist with eight undistinguished species in the Onchidoridae, five in the Idulidae, etc.

After the citation of each species an invaluable and essential part of the key is the reference to standard works for further description, illustration and notes on distribution. Additional works are included in the adequate bibliography, and there is a good index. One of the merits of this key is its reliance on external, not internal, characters, thus allowing identification of a specimen without destroying it in the process. Dr. Smith's key can be recommended to all conchologists interested in the marine gastropods and is something to have at hand at all times. Conchologists will find it is especially useful in identifying the Pyramidellidae, Trochidae and Rissoidae.

JOHN E. LLEWELLYN JONES

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THE CONCHOLOGICAL SOCIETY OF GREAT BRITAIN AND IRELAND

INCOME AND EXPENDITURE ACCOUNT FOR THE YEAR ENDED 31st DECEMBER, 1973

	£	£
Publications:		
Newsletter		412·09
Journal:		
Volume 27 No. 4	191·30	
Volume 27 No. 7	889·91	
Volume 27 Index	83·00	
Volume 28 No. 1	509·68	
		1,673·89
Expenses of Meetings ...		98·89
Printing, Stationery and Postage		262·87
Officers' Expenses		93·61
Subscriptions		7·00
		2,548·35
Net Surplus		357·54
		£2,905·89

	£	£
Fees and Subscriptions:		
Membership Fees	1,502·81	
Subscribers	802·01	
Entrance Fees	24·00	
		2,328·82
Donations-General	47·34	
Sales:		
Advertising	1·00	
Student Papers	36·23	
Journals	53·54	
Newsletter	3·84	
Sundries	6·18	
		100·79
Investment Income:		
General Account	372·20	
Life Members Fund	56·74	
Reserve and Research Fund	66·42	
	495·36	
Transfer to Reserve and Research Fund	66·42	
		428·94
		£2,905·89

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BALANCE SHEET AS AT 31st DECEMBER, 1973

	£	£
Fees and Subscriptions in Advance		192·34
Life Membership Fund... ...		850·00
Reserve and Research Fund ...		1,061·32
Capital Account		
Balance Bt./Fwd.	5,575·86	
Add Surplus	357·54	
		5,933·40
		£8,037·06

	£	£
Cash at Bank: Current Account ...	887·32	
Deposit Account ...	1,278·57	
Cash in Hand	6·77	
		2,172·66
Investments		
£400 5% Treasury Stock 1986/89 (£219·00)	344·00	
£500 5¾% Deb. Stock Mersey Docks and Harbour Board 1976/78	460·85	
£737·67 6¾% Stock Greater London Council (£630·70) ...	721·52	
2,514 Units M. & G. Dividend Fund (£1,674·32)	1,522·06	
£400 5⅜% Loan City of Norwich	400·00	
£800 5½% Loan London County Council	769·20	
1,620 Scotincome Units (£639·90)	892·95	
£875 Spillers 7% Deb. Stock 1978/83	753·82	
		5,864·40
		£8,037·06

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J. Conch. 28: 253–261 (1974)

PROCEEDINGS OF THE CONCHOLOGICAL SOCIETY OF GREAT BRITAIN AND IRELAND

885th (ordinary) meeting, 17 march 1973

Communications. "*Azeca* in Britain" by C. R. C. Paul. "The land operculate genus *Pollicaria* Gould, a systematic revision" by T. Pain. "Caithness land and freshwater molluscs" by R. G. Meiklejohn. "Protective resemblances in British *Lamellaria*" by T. E. Thompson. "Sub-fossil and modern land snail faunas from rock rubble habitats" by J. G. Evans and Hilary Jones. "Pteropods from Scottish and adjacent waters" by D. W. McKay. "Palearctic element in late Quaternary lake faunas of southern Ethiopia" by D. S. Brown. "Notes on the occurrence of *Vertigo angustior* (Jeffreys) in Great Britain" by A. Norris and B. Colville.

Lecture. "The oyster in literature" by A. E. Ellis.

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R. M. Dixon, 19 Blaker Ave., Rochester, Kent.
Mrs. S. V. Freeman, 22 Clarefield Road, Leicester, LE3 6PA
B. F. Keegan, B. Sc., M. Sc., Ph. D., Zoology Department, University College, Galway, Eire.
A. G. H. Osborn, F. L. S., 20 High Street, Olney, Bucks.
D. Thompson, 62 May Street, Luton, Beds.

886th (ORDINARY) MEETING, 14 APRIL 1973

Communications. "Daytime resting sites of *Agriolimax reticulatus* and *Arion intermedius* on grassland" by D. Pallant.

Lecture. "Some critical small British land molluscs" by Dr. C. R. C. Paul.

Elections

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Mrs. E. Tomlinson, Weaver Grove Farm, Winsford, Cheshire

887th (ORDINARY) MEETING, 19 MAY 1973

Communications. "The European species of the genus *Gibbula* Risso 1826" by F. Nordsieck. "A review of the known predators of *Littorina saxatilis* (Olivi 1792)" by C. W. Pettit. "A rare Sowerby leaflet" by Mrs. N. F. McMillan.
Lecture. "*Lymnaea truncatula*, the snail host of the liver fluke" by Dr. C. B. Ollerenshaw.

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Mrs. R. B. Lewis, 23 Hibbert Street, Luton, Beds.
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A. C. Tingley, 23 Knappmill Way, Bellingham, London SE6 3TD.
Mrs. S. Tomkins, 10 Leathwaite Close, Luton, Beds. LU3 2TG.

888TH (ORDINARY) MEETING, 20 OCTOBER 1973

Communications. "*Boettgerilla pallens* Simroth, a new British species" by B. Colville and A. Norris. "A new species of *Cypraea* from West Africa" by P. Clover. "Three new species of Marginellidae from the Indian Ocean" by P. Clover.

889TH (ORDINARY) MEETING, 17 NOVEMBER 1973

Lecture. "Post Glacial history of British land molluscs" by Dr. M. P. Kerney.

ELECTIONS

H. Bunje, MD, FRCP, 73 Temple Sheen Road, London, SW14 7RS.
Miss M. Cobley, 33 Worthfield Drive, Truro, Cornwall.
Mrs. A. E. Cox, M.A., 11 Dean Court, Brierly Hill, Staffs.
G. H. J. Cox, 7 King John's Road, North Warnborough, Onham, Hants.
H. E. M. Drott, B.Sc., Dip. Ed., 31 Canaan Lane, Edinburgh, EH10 4SX.
R. J. Driscoll, B.Sc., 10 Sidney Close, Great Yarmouth, Norfolk.
T. Gascoigne, B.Sc., Ph.D., 14 York Grove, Peckham, London, SE15.
G. Hellman, A.I.B., c/o Midland Bank Ltd, 431 Oxford Street, London.
A. E. le Gros, 155 Glenfarg Road, Catford, London SE6 1XW.
J. H. Mathias, B.Sc., Ph.D., Department of Biology, Leicester Museum and Art Gallery, New Walk, Leicester, LE1 6TD.
F. Maurasse, Ph.D., Department of Physical Sciences, Florida International University, Tamiami Trail, Miami, Florida.
Mrs. M. Parker, 68 Hornton Street, Kensington, London, W8.
N. J. A. Phillips, B.Sc., Windyridge, Sandhurst, nr. Hawkhurst, Kent.
Mrs. E. Platts, Tiverton, Quarry Road, Belfast, B14 2NP.
G. A. Te, Mollusk Division, Museum of Zoology, University of Michigan, Ann Arbor, Michigan, 48104, U.S.A.
Mrs. C. A. Thompson, Hearts Delight, 23 Midhurst Road, Fernhurst, nr. Haslemere, Surrey.
M. Ware, MD., FRCP, 99 Nottingham Terrace, London, NW1 4QE.

890TH (ORDINARY) MEETING, 15 DECEMBER 1973

Lecture. "Field meeting reminiscences" by J. Llewellyn Jones.

ELECTIONS

A. D. Court, L.R.I.C., 41 Mincing Lane, Rowley Regis, Warley, Worcs.
A. J. Duarte Gil, Av. E. U. A., 122–9D, Lisboa 5, Portugal.
P. Flynn, L.R.O.(6), D097348T, 45 Grant Road, Farlington, Portsmouth, Hants.
Mrs. P. Harris, 29 Grandisson Drive, Ottery-St-Mary, Devon.
D. Lindley, 28 Ghyll Road, Leeds, LS6 3LY.
A. T. Sumner, M.A., D. Phil., Fetteresk, West Street, Penicuik, Midlothian, Scotland.

PROCEEDINGS

891st (ORDINARY) MEETING, 19 JANUARY 1974

Lecture. "A Hispanic view of the shell" by Miss E. F. Fogan.

ELECTIONS

K. D. Thomas, Department of Human Environment, London University, Institute of Archaeology, 31–34 Gordon Square, London, WC14 0PY.
J. Lever, 4 Northview Cottages, Widford, nr. Ware, Herts.

892nd (ANNUAL GENERAL) MEETING, 23 FEBRUARY 1974

Presidential Address. "The history of the Society" by T. E. Crowley.
Election of auditors. W. F. Edwards and C. W. Pettitt were re-elected for 1974/75.

ELECTIONS

R. Anderson, B.Sc., Ph.D., 26 Haddington Gardens, Belfast, BT6 0AN.
Professor E. Bombieri, Instituto Matematico, Universita di Pisa, 56100, Pisa, Italy.
Miss W. Brown, 68 Clifton Road, Shirley, Southampton, Hants.
M. Sinclair, B.Sc., Lynwood Lodge, 10 Liddesdale Road, Hawick, Roxburgh, TD9 0ES.
Mrs. S. C. Vowles, Appletrees, Leafy Lane, Tring, Herts.

SPECIAL GENERAL MEETING, 23 FEBRUARY 1974

Rule No. 8 of the Society's rules was amended by the unanimous decision of the members present to read as follows:-
"The Society shall be governed by a Council consisting of the following Officers:- a President, Treasurer, Editor, Secretary, Recorder for non-marine Mollusca, Recorder for marine Mollusca, Newsletter Editor and Officer in charge of junior membership, together with six other members all of whom shall be elected annually by ballot; and vice-presidents. All Officers shall be unpaid."

REPORT OF THE COUNCIL 1973–74

Membership. It is with deep regret that the Society has to report the deaths of the following members: Mrs. G. Herbert 1968–74; J. F. Ogle-Skan 1960–74.

Total membership now stands at 574 and comprises the following categories: Full Members 478, Family members 24, Life Members 17, Honorary Members 3, Junior members 52. In addition there are now 165 Subscribers, an increase of 20. During the year only one Subscriber defaulted through non-payment and 3 subscriptions were cancelled.
Meetings. One Annual General Meeting and 7 Ordinary Meetings were held in the Conversazione Room at the British Museum, Natural History.
Publications. Two parts of the *Journal of Conchology*, Vol. 28 pts. 1 and 2 were issued, together with Quarterly 'Conchologists' Newsletters', an Annual Membership List and a Syllabus of Meetings. No 'Papers for Students' were issued but the Marine Concordance was compiled by Mrs. S. M. Turk and issued to all Membeıs.

REPORT ON JUNIOR MEMBERSHIP 1973–74

Membership. 11 new Junior Members have been elected, 7 have transferred to full Membership

and 7 have been removed for varying reasons. Total Junior Membership is now 52, a slight decrease on last year.

Meetings. As an experiment, 6 meetings in the London area were specially arranged for Junior Members. 3 were informal indoor meetings at Kew and had an average attendance of 3 Juniors and 2 Seniors. The other 3 were field meetings to Box Hill, Surrey (mostly land molluscs), Marsworth, Bucks (mostly freshwater) and Herne Bay, Kent (mostly fossil and marine molluscs). Average attendance was 2 Juniors and 4 Seniors. Both types of meeting were successful and it is intended to have a similar programme for the forthcoming year.

Publications. No new issues of 'Papers for Students' appeared during the year and none were reprinted. Sales of 'Papers for Students' realised £40·94.

TREASURER'S REPORT, 1973

The Society's income from Members' Subscriptions and *Journal* Subscribers has continued to show a steady increase.

As forecast in the 1972 Report, it was possible to add to the investments, and 875 Spillers Debenture Stock 1978/83 and 1,200 Scotbits units were purchased for the benefit of the General Account at a total cost of £1,494·52. Our income from investments is therefore considerably increased.

The income from Covenanted Subscriptions shows a decrease, a reduction in the standard rate of Income Tax having lessened the amount which we are entitled to reclaim. New Covenanted Subscribers would be very welcome.

1973 was an expensive year for the *Journal of Conchology*. It was necessary to reprint Vol. 27 No. 4 at a cost of £191·30, and Vol. 27 No. 7 was an unusually large part. The account for Vol. 28 No. 2 (published in 1973) was not received in time for inclusion, but an adequate amount has been retained in the deposit account to cover this expense.

The *Conchologists' Newsletter* appeared quarterly, but only 3 of the 4 issues are shown in the year's total, since the account for the December issue was not received in time for inclusion.

No *Student Paper* was published during the year, but the Society produced an addition to its usual publications in the *Marine Concordance.* The cost of this has been debited to the Reserve and Research Fund.

As mentioned in the 1972 Report, the Linnean Society's charge for hire of rooms was carried forward into 1973, which explains the large total appearing under this heading.

24 Members and 4 Junior Members are in arrears with 1973 Subscriptions, and have been removed from the mailing-lists. It has further been decided that in view of the present high cost of publications they can now only be sent to Members whose Subscriptions are paid up for the current year.

MARJORIE FOGAN
Hon. Treasurer

FIELD MEETINGS

Nine field meetings were held during 1973 as follows: 24–25 March, Weymouth, Dorset; 28 April, Chaldon, Surrey; 26 May, Norwich, (joint meeting with the Geological Society of Norfolk); 9 June, South Leicestershire; 7 July, Sandwich, Kent, (joint meeting with the British Shell Collectors Club); 26 August, Bexhill, Sussex; 30 September, Northampton, (joint meeting with the Northampton N.H.S.); 6 October, Ipswich, Suffolk; 21 Oct., Burnham Beeches, Bucks. Eight meetings were also held by the Northwestern Conchological Group; 5 May, Chipping Lancs.; 26 May, Frodsham Marshes, Cheshire; 16 June, Winsford,

Cheshire; 10 July, Ince Moss, nr. Wigan, Lancs.; 14 July, Moston Tip, Manchester; 4 Aug. Speke Hall, Lancs; (In conjunction with Liverpool Naturalists' Field Club); 1 Sept., Shropshire Union Canal; 13 Oct. Brookhays Covert Nature Reserve, Cheshire;

Thanks are due to the following for leading these meetings: Mrs. E. Tomlinson, Mrs. N. F. McMillan, Mrs. M. Fogan, Mrs. C. J. Pain; Drs. L. Lloyd-Evans and M. P. Kerney, and Messrs. A. Lord, C. W. Pettitt, J. Llewellyn Jones, D. R. Worth, P. Cambridge, I. M. Evans, A. P. H. Oliver, G. Osborn, and R. A. D. Markham.

T. Pain

RECORDER'S REPORT: NON-MARINE MOLLUSCA

A. 10-Kilometre Square Mapping

The mapping scheme is now moving towards the end of its first phase, which should shortly culminate in the publication of a provisional distribution atlas. The 1973 season saw steady progress in improving coverage. Some 10,000 new 10-km grid-square records were incorporated. Extraction of old (pre-1950) Census data is now complete.

B. Vice-county Records

The following new records have been verified since the last Recorder's Report (*J. Conch., Lond.* **28**:199). Unless otherwise stated, the date of collection was 1973. Where no collector's name is given, the record was made during the Society's mapping expedition in September to southern Scotland and the Border country, the members of the party being Mrs. M. Fogan, Mrs. E. B. Rands, D. C. Long, A. Norris, C. R. C. Paul, A. J. Rundle and the writer (see also p. 225).

Channel Isles (0): *Zonitoides excavatus,* St. Brelades' Bay, Jersey (WV 5848), Dr. June Chatfield.
Somerset North (6): *Helix pomatia,* Stoney Stoke (31/7032), R. G. H. Burne; *Arion intermedius,* Clevedon (31/4372), M. P. Kerney.
Wilts South (8): *Acicula fusca,* Stourhead (31/7733), M. P. Kerney.
Isle of Wight (10): *Lymnaea stagnalis,* Havenstreet (40/5590), R. C. Preece.
Bucks (24): *Planorbis laevis,* Grand Union Canal, Marsworth (42/9214), A. J. Rundle.
Suffolk East (25): *Hydrobia neglecta,* Aldeburgh Marshes (62/4655), M. J. Bishop: *Anodonta complanata,* North Cove Staithe (62/4691), D. C. Long.
Bedford (30): *Limax cinereoniger,* Studham (52/0316), Mrs. E. B. Rands.
Gloucester East (33): *Acanthinula lamellata,* Upton St. Leonards (32/81), H. Dixon Hewitt, 1920 (Thetford Museum).
Monmouth (35): *Lauria anglica,* Llanthony Priory (32/2927), D. C. Long; *Pisidium tenuilineatum,* R. Monnow, St. Maughams (32/4717), M. J. Bishop.
Hereford (36): *Pupilla muscorum, Oxychilus draparnaudi,* Shucknall (32/5842), M. P. Kerney; *Clausilia rolphii,* Dinmore (32/5151), A. Norris; *Pisidium pseudosphaerium,* Moccas Park (32/3442), S. P. Dance; *Pisidium tenuilineatum,* Aymestrey (32/4266), M. P. Kerney.
Worcester (37): *Pomatias elegans,* Tiddesley Wood (32/9344). D. C. Long.
Salop (40): *Vertigo moulinsiana,* Sweatmere Fen (33/4330), Mrs. M. Cameron; *Vallonia pulchella,* Diddlebury (32/5085), A. Norris; *Monacha granulata,* Easthope Lake (32/5794), A. Norris.
Brecon (42): *Abida secale,* Daren Cilau, Crickhowell (32/2015), D. C. Long.
Radnor (43): *Unio pictorum,* R. Wye, Hay-on-Wye (32/2242), S. P. Dance.
Montgomery (47): *Aplexa hypnorum,* Wern (33/2414), C. R. C. Paul.
Merioneth (48): *Pisidium pulchellum,* Bala (23/9236), C. R. C. Paul.
Lincoln South (53): *Hydrobia neglecta,* Wyberton Marsh (53/3638), M. J. Bishop; *Sphaerium solidum,* Timberland Delph, Kirkstead (53/1761), E. J. Redshaw.
Lincoln North (54): *Sphaerium solidum,* R. Witham, Brothertoft (53/2647), Mrs. E. B. Rands, 1968; *Pisidium moitessierianium* Steeping River, Wainfleet (53/4859), E. J. Redshaw.

Derby (57): *Segmentina complanata, Pisidium hibernicum,* Cromford Canal, Whatstandwell (43/3354), M. P. Kerney.

Lancaster South (59): *Pisidium lilljeborgii,* White Coppice (34/6119), Mrs. M. Fogan.

York South-east (61): *Arion lusitanicus,* Withernsea (garden; 54/3427), A. Norris.

York North-west (65): *Bithynia leachii,* Bedale (44/2688), *Agriolimax caruanae,* Kirby Wiske (44/3784), L. Lloyd Evans; *Truncatellina cylindrica,* Easby Abbey (45/1800), Baker Hudson, 1883 (Dorman Museum, Middlesborough).

Northumberland South (67): *Agriolimax agrestis,* Mounces (35/6688); *Agriolimax caruanae,* Falstone (35/7287).

Cheviotland (68): *Potamopyrgus jenkinsi,* Alnwick (46/1914), Mrs. E. B. Rands, 1968.

Dumfries (72): *Vallonia excentrica,* Cummertrees (35/1465); *Cepaea hortensis, Agriolimax caruanae,* Glencrosh (25/7688); *Monacha granulata,* Canonbie (35/3976)); *Milax budapestensis,* Canonbie (35/3878); *Milax sowerbyi, Limax flavus,* Moffat (36/0705); *Limax maximus,* Lockerbie (35/1681); *Limax cinereoniger,* Drumlanrig Woods (25/8603).

Kirkcudbright (73): *Vallonia pulchella,* Martyrs Tomb Bridge (25/9179).

Wigtown (74): *Acicula fusca, Acanthinula lamellata, Hygromia subrufescens,* Glenluce (25/1957); *Planorbis leucostoma,* Stoneykirk (25/1152); *Agriolimax agrestis,* Tarf Bridge (25/2564).

Ayr (75): *Physa fontinalis, Planorbis carinatus, Pisidium amnicum,* R. Irvine, Dreghorn (26/3837); *Planorbis laevis,* Glenbuck Loch (26/7528); *Planorbis crista,* Gateside, Ayr (26/3720); *Segmentina complanata,* R. Irvine, Kilmarnock (26/4637); *Acroloxus lacustris, Vertigo antivertigo, Agriolimax agrestis, Pisidium pulchellum,* Belston Loch (26/4716); *Oxychilus draparnaldi, Pisidium casertanum,* Maybole (26/3009); *Milax budapestensis,* Annbank (26/3921); *Sphaerium lacustre,* Netherton, Dalrymple (26/3713): *Pisidium personatum,* Ochiltree (26/4917).

Renfrew (76): *Vertigo antivertigo, Punctum pygmaeum,* High Dam, Eaglesham (26/5551); *Acanthinula lamellata,* Majeston (26/2372); *Agriolimax agrestis,* Loch Thorn (26/2672); *Agriolimax caruanae,* Soame Bridge (26/5148).

Lanark (77): *Planorbis laevis,* Glenbuck Loch (26/7528); *Acanthinula lamellata, Limax cinereoniger,* Yonderton, Lesmahagow (26/7936); *Retinella pura, Agriolimax agrestis, Agriolimax caruanae,* Strathaven (26/6946).

Peebles (78): *Hygromia striolata,* Neidpath Castle (36/2340), Dr. Shelagh Smith.

Selkirk (79): *Vertigo lilljeborgi, Agriolimax agrestis,* Loch of the Lowes (36/2319); *Monacha granulata,* Redfordgreen (36/3615).

Roxburgh (80): *Bithynia tentaculata, Planorbis planorbis, Pisidium pulchellum,* Williestruther Reservoir (36/4911), Magnus Sinclair; *Acroloxus lacustris,* Branxholme Wester Loch (36/4211), Magnus Sinclair; *Sphaerium lacustre,* Kershope (35/4783), Magnus Sinclair; *Acanthinula lamellata,* Jedburgh (36/6318); *Agriolimax agrestis,* Falnash (36/3906); *Agriolimax caruanae,* Minto (36/5921).

Berwick (81): *Lymnaea glabra,* Gordon Moss (36/6342), Arthur Smith; *Agriolimax agrestis,* Westruther (36/6349).

Perth Mid (88): *Vertigo pusilla,* Birks of Aberfeldy (27/8548), M. J. Bishop.

Perth East (89): *Agriolimax agrestis,* Straloch (37/0463), H. W. Waldén.

Aberdeen South (92): *Acanthinula lamellata,* Linn of Muick (37/3389), M. J. Bishop; *Limax tenellus,* Birsebeg (37/5397), E. Kellock; *Agriolimax agrestis,* Glen Clunie (37/1588), H. W. Waldén; *Pisidium lilljeborgii,* Loch Urotachan (37/1278), M. J. Bishop.

Banff (94): *Limax flavus,* Portknockie (38/46), E. Kellock.

Main Argyll (98): *Hydrobia neglecta,* Easdale (17/7617), T. Warwick.

Ross West (105): *Potamopyrgus jenkinsi,* Gairloch (18/87), T. Warwick; *Vallonia excentrica,* Melvaig (18/7386), *Vallonia costata,* Gairloch (18/8175), *Hygromia striolata, Helicella caperata,* Gairloch (18/8075), *Helix aspersa, Milax gagates,* Smithstown Strath. (18/7977), *Pisidium milium,* Strath Gairloch (18/7978), all R. G. Meiklejohn.

Sutherland East (107): *Helicella caperata,* Ballinreach (29/9308), R. G. Meiklejohn.

Sutherland West (108): *Agriolimax agrestis,* Melness (29/5764), R. G. Meiklejohn.

Caithness (109): *Agriolimax agrestis,* Reay (29/9765), R. G. Meiklejohn.

Outer Hebrides (110): *Hygromia striolata,* Stornoway (19/43), D. Heppell, 1962.
Shetland (112): *Milax gagates,* Symbister, Whalsay (68(HU)5362), P. Burns.
Cork West (H3): *Milax budapestensis,* Dunmanway (W 2251), M. J. Bishop.
Down (H 38): *Planorbis vortex,* R. Lagan, Belfast (J 3470), *Oxychilus draparnaudi, Boettgerilla pallens,* Mountstewart (J 5669), *Zonitoides excavatus,* Mourne Park (J 2616), all R. Anderson.
Antrim (H 39): *Vitrina pyrenaica,* Glenariff Glen (D 2020), R. Anderson.

The most important discovery of the past year has been the recognition of the central European species *Sphaerium solidum* (Normand) for the first time in Britain. Specimens were found by Mr. E. J. Redshaw in a large drain by the River Witham near Kirkstead, on the boundary of v.c.'s 52 and 54. Further examples were subsequently detected in a collection made by Mrs. E. B. Rands in 1968 some miles further downstream at Brothertoft. It seems likely that the species must occur at other places along the river.

A second site for *Boettgerilla pallens* has been found in the British Isles, at Mountstewart, Co. Down. The habitat is disturbed waste ground on the shores of Strangford Lough close to ornamental gardens, and the species seems likely to have been recently introduced. It was associated with *Oxychilus draparnaldi* and other synanthropic species. The same collector (Dr. R. Anderson) has also found *Vitrina pyrenaica* for the first time in Northern Ireland, living in abundance in an acid mixed coniferous/deciduous wood at Glenariff Glen, Co. Antrim.

A record of some historic interest is Mr. D. C. Long's find of *Abida secale* on a rubbly Carboniferous limestone hillside near Crickhowell, Breconshire. *A. secale* was reported from Crickhowell by J. G. Jeffreys before 1830, but has never subsequently been confirmed in Wales.

Agriolimax agrestis is recorded from twelve additional Scottish vice-counties. This north European species is clearly widespread in Scotland, especially in mountain areas.

The new locus for *Vertigo moulinsiana* from an alder carr (Sweatmere Fen) in Shropshire serves to link the occurrences of this species in south-east England with those on the central plain of Ireland.

Finally, the discovery of *Zonitoides excavatus* in Jersey (Channel Islands) is of particular interest, as the species has never been recorded from France, but it now seems highly likely that it must occur there on the adjacent mainland only a few miles away.

M. P. Kerney

RECORDER'S REPORT: MARINE MOLLUSCA

The brevity of this report is in inverse ratio to the amount of recording and general activity during 1973; in the interests of economy much of the Area reporting will appear in the 'Newsletter'. Master lists from 24 Areas have been received to date and a presentation of them is being compiled, including information on whether found living or as shells only, and according to date classes pre-1900, 1900-1950 or post-1950.

Mrs. Celia J. Pain and I have compiled Information Sheets which should soon be ready for circulation to those wishing to help with the scheme. Basic information is included on the aims of the work, a guide to procedure, easily available books, the list of Area Representatives and definitions of the Sea Areas.

In August Dr. June Chatfield gave a talk on the British marine mollusc recording activities at the 2nd International Symposium of the European Invertebrate Survey. Much interest was shown in our work, which was said to be the most advanced in Europe at present. At the Meeting of National Biological Societies, marine interests were represented by Mrs. Beryl Rands and Dr. Chatfield.

January 1974 has seen the publication of Dr. Shelagh Smith's 'Key to the British marine Gastropoda' (*Royal Scottish Museum. Information Series,* Natural History, 2) and this will cer-

tainly help students to use the existing illustrated literature, which is largely key-less. At the end of this year the first of the two volumes of Dr. T. E. Thompson's monograph on the British Opisthobranchia is due for publication, whilst a key to this much-neglected section of the Gastropoda is being prepared for the Linnean Society's *Synopses of the British Fauna* by Dr. Thompson and Mr. G. Brown.

Records from the Areas

These are restricted to new or noteworthy records from those Areas which have good basic lists. Sea Area numbers are in brackets, and unless otherwise stated all specimens were found living, and during 1973. Authors' names are not included, as the nomenclature follows that used in the *Concordance to the Field Card for British Mollusca* (1973).

Orkney (3): *Ammonicera rota; Caecum glabrum*; both shell sand: 1966: Miss E. Fogan. These are both scarce species, and it is the most northerly report of *Ammonicera. Aegires punctilucens; Onchidoris fusca; O. depressa* (confirmation of an earlier Conch. Soc. map record which carried no data); *Precuthona peachii; Facelina auriculata* (confirmation of map record); *Leucophytia bidentata; Myrtea spinifera; Abra alba; Corbula gibba; Saxicavella jeffreysi*: all from I. Smith per A. Skene. The bivalves were shells only taken from a shell scrape in Scapa Flow.

Northumberland (9): *Ammonicera rota; Graphis albida:* both from holdfast of *Laminaria hyperborea:* 1970: P. G. Moore. The first of these species has not previously been recorded from anywhere on the E. coast of Britain, apart from a 19th century record from shell sand at Scarborough, whilst the second is more widely distributed but distinctly rare.

Yorkshire (11): *Erato voluta*: one shell: A. Norris. This is a scarce species, particularly in the north, and it is a new record to the comprehensive list published in the two-volume work on the Natural History of the Scarborough District, published by Scarborough Naturalists' Society in 1956.

Norfolk (12): The following species are additional to the list published by Hamond, R., 1972 (*Trans. Norfolk Norwich Nat. Soc.* **22**: 271–306). *Emarginula reticulata*: one worn shell; *Tricolia pullus*: 6 shells; *Cingula cingillus*: 3 shells; *Turbonilla elgantissima*: one worn shell; *Cardium scabrum*: one valve; *Lasaea rubra*: one shell. All from mouth of the Humber in 30′: 1971: D. A. J. Taylor. *Ensis arcuatus*: Thorham: 1960: one shell: D. S. Davies.

Portland (16): *Lepidopleurus asellus*: Weymouth Bay; *Actaeonia senestra*: Osmington Mills; *Eubranchus farrani*: Portland Harbour; *Teredo malleolus:* Ringstead Bay: shell only; *Sepia elegans*: Osmington Mills: worn shell. All from D. R. Seaward. *Rissoa albella*: H. M. J. Bowen.

Plymouth (West Channel) (18): *Onchidoris luteocincta*; *Cadlina laevis; Atagema gibba.* All found off the Lizard by B. E. Picton and determined by Dr. T. E. Thompson who writes that the first is probably a common species, overlooked until recently, and the second is rare in the south, having its centre of distribution in Arctic waters. The third represents a genus never before found on the British coast (see p. 233). *Eubranchus farrani*: The Lizard: C. Hayton; an unusual orange on dark grey variety.

North Cornwall (20): *Alvania carinata*: Hartland Quay, Devon: one specimen: M. J. Bishop. Records of this species—especially found living—are very sparse, and confined to the S. and W. coasts of Britain.

Bristol Channel (21): *Ocenebra aciculata*: Porlock Weir, Somerset: J. H. Crothers. This is a most interesting record of a species hitherto regarded as Sarnian, the discovery of which on the Welsh coast lends credence to data (Tenby and Scilly) accompanying specimens in the County Museum, Truro, Cornwall. Mr. Crothers will be searching for more examples in the same locality, and recorders are asked to remember the possibility of this species being present. It may have been overlooked as a juvenile example of *Ocenebra erinacea*. Dr. T. E. Thompson reports the following species taken during dives off the Pembrokeshire coast: *Hermaea bifida*; *Crimora papillata; Polycera elegans; P. faroensis;*

Onchidoris luteocincta; Okenia elegans; Favorinus blianus (in press, as a new species). Mr. T. Pain points out that *Colus islandicus*, generally considered to be a rare northern species, was taken off the Smalls Rocks, Pembrokeshire by H. K. Jordan in 1889, and that this series of specimens is in the Marshall Collection in the National Museum of Wales (see *J. Conch., Lond.* **13**: 208–209).

Anglesey (23): *Abra tenuis*: in lagoon connected with the sea only by culverts: E. I. S. Rees. Dr. Rees suggests that this species, which was abundant, has been overlooked in the past. Like *Cardium lamarcki* it is known from very few places on the W. coast of Britain, owing to the lack of suitable lagoon-type habitats.

Liverpool Bay (24): Mrs. N. F. McMillan writes that she has no species to add to L. D. Harfield's "excellent list for the Area in *Conch. Newsletter* No. 29, June 1969" except for a record of *Nassarius pygmaeus* from Ainsdale c.1950, recorded by L. W. Grensted in *J. Conch., Lond.* **23**: 125. It is not clear whether this refers to a shell or a living example.

Isle of Man (26): Dr. A. R. Brand reports the following species from Area 26 since the publication of the 2nd edn of the Marine Fauna in 1963: *Scutopus ventrolineatus* Salvini-Plawen; *Spiratella retroversa*; *Scrobicularia plana*. *Scutopus ventrolineatus* is a member of the Solenogastres and is new to the British list: it was described in 1968 (see *Sarsia* **31**: 105–126 and for additional description, *Sarsia* **45**: 1–16) Dr. N. S. Jones considers that the animals determined by himself and included in the 1963 Fauna as *Chaetoderma nitidulum* should really be this new species. *Lepton squamosum* was left out of the 1963 list since its status depended only on shells, whilst the following species listed in the 1st edn. (1937) were dropped *pro tem* owing to doubts on their taxonomic status: *Lora rufa; Limapontia depressa; Polycera nothus; Trinchesia viridis.*

Belfast (28): *Crepidula fornicata*: Strangford Lough: Mrs. E. Platts. Mrs. Platts writes that the recent establishment of this pest is bad news for the people now cultivating oysters in the Lough. In 1966 Dr. P. J. Boaden reported a species new to Britain, *Lepidomenia hystrix* Marion & Kowalevsky, 1886 (Solenogastres), a member of the interstitial fauna in Strangford Lough. (see *Beroff. Inst. Meeresforsch. Bremenhaven* Stonderband **2**: 125–130).

Fastnet (37): Mr. Michael Long continues to find new and noteworthy molluscs from Dingle Bay (see O'Riordan, C. E., 1972. *Irish Nat. J.* **17**: 253–255 and *J. Conch.* **28**: 41–42). The records of *Charonia lampas* and *Rossia macrosoma* are of especial interest.

As this is my last Report before resigning from the Marine Recordership I would like to thank most sincerely the many people from whom I have received so much support in forwarding the Marine Census work. Especially I would like to thank our Secretary Mrs. Beryl Rands who has worked so closely and helpfully with me, mitigating a situation in which I have been unable to attend a single Council meeting during these past eight years!

J. CONCH. *28*: 262–263 (1974)

PUBLICATIONS OF THE REVD. H. E. J. BIGGS

JC = Journal of Conchology

Natural History Notes. *The Spectator,* May-Sept, 1913.
Peasant Life in Venetia. *Magazine of Engineers' Dept. of Great Eastern Railway,* 1919/20.
Description of a new *Clausilia* from Persia. *JC* **19**:164, 1931.
Rumina decollata (L) in captivity. *JC* **19**:279, 1932.
Supposed new variety of *Melanopsis doriae* Issel. *JC* **20**:60, 1934.
A new *Clausilia* from Asia Minor. *JC* **20**:253, 1936.
Collecting the Mollusca of the Iranian plateau. *Nautilus* **50**:8–12, 1936.
Mollusca of the Iranian plateau. *JC* **20**:342-348, 1937.
Two new species of Coleoptera. *Entomol. Monthly Mag.* **81**:110-111, 1945.
Two new land snails from Asia Minor. *JC* **22**:223-224, 1946.
A new species of *Rhagonycha. Entomol. Monthly Mag.* **83**:1947.
Diptera of East Anglia—some additions. *Entomol. Monthly Mag.* **87**:237, 1951.
Notes on *Hygromia cinctella* (Draparnaud). *JC* **24**:177-178, 1957.
Nucella lapillus (L) with double operculum. *JC* **24**:174, 1957.
(With F. H. Cozens) Note on *Acme fusca* (Montagu) in West Kent. *JC* **24**:233, 1958.
A large example of *Potamopyrgus jenkinsi* (Smith). *JC* **24**:238, 1958.
A new species of *Siphonaria* from the Persian Gulf. *JC* **24**:249, 1958.
Littoral collecting in the Persian Gulf. *JC* **24**:270-275, 1958.
A contribution to the study of the genus *Eremina* Pfeiffer, 1885. *JC* **24**:332-342, 1959.
Some land Mollusca from northern Iraq. *JC* **24**:342-347, 1959.
Mollusca from prehistoric Jericho. *JC* **24**:379-387, 1960.
(With L. L. Grantier) A preliminary list of the marine Mollusca of Ras Tanura, Persian Gulf. *JC* **24**:387-392, 1960.
Review: A monographic revision of the African land snails of the genus *Burtoa* by T. E. Crowley & T. Pain. *JC* **24**:442, 1960.
Mollusca of the Iranian plateau 2. *JC* **25**:64-72, 1962.
Obituary: Harry Beeston 1865-1962. *JC* **25**:132, pl.7, 1962.
On the Mollusca collected during the excavations at Jericho, 1952-58, and their archaeological significance. *Man* No. **153**:125-128, Aug. 1963.
The first European Malacological Congress: a brief report. *JC* **25**:207-211, 1963.
Obituary: Hans Schlesch 1891-1962. *JC* **25**:202-203, pl. 12, 1963.
Mollusca from the Dahlak Archipelago, Red Sea. *JC* **25**:337-341, 1965.
What do you know about shells? *The Lightship,* 1965.
What can I do to find out more about shells? *Boys' Own Paper,* Aug. 1964.

Introduction: *Proc. first Europ. malac. Congr.* **1**:1-4, 1965.

(With C. Wilkinson) Marine Mollusca from Malta. *JC* **26**:52-65, 1966.

A new species of *Littorina* from Eilat, Israel, and notes on its affinities with *Littorina novaezelandiae* Reeve. *JC* **26**:137-139, pl. 7, 1966.

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On a proposed new genus of cerithiid Mollusca from the Dahlak Islands, Red Sea. *JC* **27**:221-223, pl. 7, 1971.

Obituary: L. W. Stratton (1900-1971). *JC* **27**:427-428, pl. 16, 1972.

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Report on the Mollusca collected by the expedition to Bampur. *Anthropol. Papers, Amer. Mus. Nat. Hist.* **51**:333-334.

Further notes on *Monacha cartusiana* (Müller) in Suffolk. *Conch. Newsletter* No. **43**:292-293, Dec. 1972.

Reports on Junior Membership. *JC* 1964-71.

Molluscs at Redgrave Fen. *Trans. Suffolk Nat. Soc.* **15**:525-526, 1972. (with Lord Cranbrook & C. Letanka)

Marine Mollusca of the Trucial Coast, Persian Gulf. *Bull. Brit. Mus. (Nat. Hist.) Zoology* **24** (8), 1973.

(Editor's note: This list was compiled from Revd. Biggs' own notes by Mrs. Kathleen Smythe, unfortunately too late for inclusion with the obituary, see *JC* 28:131-2)

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NOTICE

Payment by Overseas Members

Overseas members are reminded that all monies due to the Society are payable in sterling.

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A HISTORY OF THE SOCIETY

T. E. Crowley
The Cottage, Church Street, Bampton, Oxon OX8 2NA

(*Presidential Address, delivered 23 February 1974*)

The sixties and seventies of last century produced a remarkable proliferation of local and specialist natural history societies, and it is perhaps worth while tracing some of the reasons for this. There had always been people interested in the things of nature, and contributions to knowledge had been made ever since the days of Aristotle; but most of these people were either professionals—that is, seamen, farmers and quarrymen whose work required them to know a good deal about some aspect of natural history, or people such as John Ray and Gilbert White, who worked in isolation, and although they contributed to knowledge more than the professionals, produced results often unchecked and undiscussed. The Age of Reason was, indeed, interested in facts much less than in philosophies, and this seems to have been true even of the Royal Society. Possibly the Linnean Society was a lonely exception, and the associations formed in most of the big cities round about 1800 all partook of the 'Literary and Philosophick' style, many of them aiming to educate the masses.

Botany was on its way to recognition as a science, encouraged by the many fine gardens being built and the exotic plants brought in by explorers. This was an applied rather than a pure study, and was followed by the sterile fashion of pteridomania half a century later, growing like a sucker on a rose. Botany however, produced few local societies.

There were quite a lot of rambling clubs in the early 1800s, but they have left no records, and we must remain in some doubt about the purposes behind the rambles; they were probably more aesthetic than scientific. There was also, it must be remembered, a Malacological and Conchological Society formed in 1838, with its own magazine, under the direction of Sowerby. It was however, stillborn.

Books of a more or less scientific nature, for museum use and the like, were beginning to be written, still by men working in isolation, and in particular, a good many works on geology. It is here that we perhaps find a clue to the slow growth of popular interest in natural science. Reading over the works of Buckland or Hugh Miller, one is impressed by the authors' anxiety to align their remarks with orthodox religion, and it is not too much to say that geologists of the day were convinced of the absolute necessity for their books to reflect the justification of Holy Writ. This, rather than scientific research, may even have been the principal motive for their work. As late as 1858 there appeared a book by J. P. Dalyell dealing in part with the Mollusca of Scotland and entitled 'The Power of the Creator in Ordaining Life among the Humbler Tribes of Animated Nature'.

Geology in particular was chained to religion, it represented the 'footsteps of the Creator', and anyone offering theories unbacked by Biblical quotations was in for trouble. Even Miller, most pious of geologists, suffered fierce criticism, and the general effect must have been a powerful discouragement for science. The general public steered clear and left matters of science to the divines and museum curators.

One factor, then, working against the formation of local and specialist natural history societies was the lack of suitable factual literature. Probably Forbes and Hanley's great work 'British Mollusca', 1853, was the first thoroughly useful book on the subject, and it is noticeable that even this did not seem to produce any recorded public reaction. Natural history continued to be thought of as a part of Christian Philosophy with which the ordinary citizen did not concern himself.

The great change came in 1859 with as important a revolution in human thinking as has ever happened in the course of a single year. First, in November was published Darwin's 'Origin of Species' which in effect, appeared to deny any need for linking science with religious belief. Darwin was no antichrist, but he saw no point in modifying his carefully reached conclusions because they did not square with orthodox Biblical statement. The teachings of the Bible were taken rather literally in those days, and few people seem then to have had the imagination to see that there was no necessary clash between the two doctrines. The Church was up in arms and the scientists were cleft into two camps. Even then the public might not have become too deeply involved had it not been for the famous British Association meeting in Oxford in the summer of the following year, which resulted in the vindication of Darwin against the assembled and hostile authority of the Church. Thus was natural science made free, and no one who studied it needed to ask permission of his spiritual adviser nor to read books of sermons. Amateurs in all branches of natural history, with increasing leisure and prosperity, made their appearance in thousands, societies and clubs sprang up in all the main centres to cater for them, and interdisciplinary and international contacts were set up.

As a relevant example we may take the City of Leeds. Here, interest in the natural sciences was considerable—as it has been ever since—and the proliferation of local amateur societies in the late sixties and early seventies was such that the Yorkshire Naturalists' Union was founded in 1870 to coordinate the work of forty of them and to provide them with facilities; this body still flourishes. Four of its founder members went on to found our own society, and although their respective obituaries are to be found in the Journal of Conchology, a few notes about them may not be out of place here.

The primary moving spirit may be said to have been John William Taylor (1845–1931), who lived in Leeds all his life, and luckily for the future Society, owned and managed jointly with his brother a colour-printing works. His early interests included entomology, but by the middle seventies all his spare time was devoted to a study of the British Mollusca, and he conducted a considerable correspondence with like-minded people all over the country. His studies took a progressive and systematic form, he gathered and arranged all the information

he was able to obtain in a way which brings one to think that the idea of a monograph on the British Mollusca was already forming in his mind. In 1874, helped by his friend Nelson, he brought out a small booklet entitled *The Quarterly Journal of Conchology,* which he sent to his correspondents so that they should have a record of the information available to him and might be better placed to fill the gaps. No charge was made for the Journal and nothing in it indicates its origin, since Taylor was dealing in a very personal way; however, it provided a great stimulus to enthusiasm, and not only records, but notes and articles came flowing in. The second volume, 1878, was given the new title of the *Journal of Conchology.*

Taylor devoted himself to a close study of the variability of British non-marine snails as well as to the organization of the Society, and it was not until 1895, when the headquarters of that body were moved to Manchester, that he felt free to devote himself to his Monograph. This came out in parts, illustrated with the greatest care by the author and printed in his own works: it was received with considerable enthusiasm, and he was still working on it almost to the time of his death nearly forty years later. No less a person than A. E. Boycott records his amazement that one man could bring such a project so near perfection.

His constant companion, William Denison Roebuck (1851–1919) a solicitor and a most skilled recorder, also lived most of his life in Leeds. His interests in the field of natural science were wide and for many years he kept a vast collection of newspaper cuttings bearing on those interests. He was early convinced of the need to record molluscan localities and undertook this task in furtherance of the needs of Taylor's Monograph. Nomenclature at that time, with its bewilderment of varietal names, was in a confused state, and Roebuck saw the need for the authentication of specimens. This is what really influenced the creation of the Society in 1876, when the four friends determined to meet together fortnightly for the purpose of examining and determining specimens received, so that these could be duly entered in the Census notebooks which had been started by Roebuck for the purpose. He was the first Honorary Secretary and drew up the first rules; the Society must realise its good fortune in the meticulous care with which his records were invariably kept, and the insistence on voucher specimens which could be checked at any time.

It was in 1881 that Roebuck decided to adopt the Watsonian vice-county system and follow the methods of the botanists. Forty years later, when he died, thirty volumes containing 60,000 locality records existed but the great revision of the Census, delayed by the War, had not yet been issued. He laid the foundations of a scheme which has put this country far ahead of any other in the accurate knowledge of its molluscan fauna.

Of the other two founders, William Nelson (1835–1906) was an older man who wrote comparatively little, but became an unequalled expert in freshwater Mollusca. A working man, he followed the trade of a currier, and after some years in Wakefield and Birmingham, where he founded local clubs, he returned to Leeds, where he took a full part in the organization of the new society, for which

his infectious enthusiasm well fitted him. The last founder to survive, Henry Crowther (1848–1937), is a more shadowy figure; examples of his portrait and his handwriting are extremely rare. His specialities were anatomy and microscopy, and his contributions to our knowledge of the Mollusca at that time were considerable. He spent his life in the curatorship of museums and resigned from the Society (which he considered a specifically Yorkshire activity) when he was appointed to Truro Museum in 1881. His later years were spent as curator of Leeds Museum and he must have been a person of decided views, because he resigned on two other occasions before accepting an honorary membership. He, like Nelson, wrote very little.

The Society has always benefited from its sound and businesslike commencement, and may count itself lucky that its founder-members all survived so long to guide it and to receive what acknowledgment it could give.

The Origin of the Journal. The first issues of the *Quarterly Journal of Conchology* came out in 1874 in plain blue covers, untitled, and with no indication of date, publisher or place of publication. They seem obviously intended in the main for circulation among Taylor's contacts; about sixteen pages long, they consisted largely of regional lists of species, a form of paper which continued in popularity for half a century and more. In his unsigned introduction, Taylor welcomes the increasing popularity of conchology and points out some of its many advantages as a study. The aims of the Quarterly were to stimulate original research and to reprint authoritative articles for general use. He attached the greatest importance to a study of geographical distribution of the species and strongly urged the formation of local lists, promising a future scheme to give a more organized character to such important work. Thus was the census scheme already in embryo. Marine studies were not neglected and the very first issue reprints an article by J. G. Jeffreys comparing the marine and non-marine Mollusca of Massachusetts with those of Europe, considering those of the former area to be derived. Charles Ashford was an early contributor, and although he never joined the Society he gave it many contributions and much support for many years and was even proposed for Council.

Following numbers of the Quarterly contained a good fifty percent of marine interest and also general notes which included recommended reading and reviews of recent publications, and even short obituaries, for instance that of G. P. Deshayes in I, 6, all unsigned but manifestly the work of Taylor. The publication was very much a one-man effort. One thing which seems evident is the doubt and differing views about subspecies and varieties—workers were evidently at sea on the matter and very little agreement on principle was to be found among them. This was to lead to bitter controversies later on.

A new species of cone, *Conus traversianus,* was described by E. A. Smith in I, 7 (still undated), and Continental local lists make their appearance. By 1878 the *Journal* issues had grown to thirty pages, with advertisements and a separate section for the description of new species. Enquiries were already being made for

early issues. The cover was a recognisable ancestor of that of the *Journal* of later years.

Birth of the Society. The first meeting of the Conchological Club of Leeds was held on 12 October 1876 at the home of William Nelson; the four founder members were there, and it was agreed to hold meetings at fortnightly intervals at the residences of the members alternately. They agreed also to a subscription of a shilling per annum, to keep records of all shells exhibited, to welcome all conchologists: and to elect Nelson as first president. Their main activity seems to have been the review and determination of all shells submitted for that purpose, and although their ambitions at first went no further than the Mollusca of Yorkshire, they quickly found themselves unable to confine their deliberations so closely. A fine collection of East African land Mollusca for instance, was exhibited by Taylor at the eighth meeting. At the second meeting, held at Crowther's, a new member, Henry Pollard, was welcomed. Crowther performed some experiments to prove the presence of phosphorus in *Mytilus* and the proceedings were recorded in the pages of *The Naturalist,* organ of the Yorkshire Naturalists' Union, a cutting being appended to the minutes. It was not until the fifth meeting that the Society decided to join the Y.N.U.

New members came slowly. At the tenth meeting, 22 March 1877, a balance sheet was submitted showing eight paid up members which, with expenses of 6s. 6d., left a satisfactory balance of 1s. 6d. At the eleventh meeting the first visitor was recorded, and at the twelfth there was a whip-round and a revised balance sheet so that Crowther's expenses as delegate to the Y.N.U. meeting at Wakefield might be paid; members contributed 3d. each. The Club was still in debt to the tune of 9d. and this must have caused anxiety, because in the end Crowther made a donation to cover his own fares.

At the fourteenth meeting an Honorary Corresponding Member (A. P. Taylor) was elected, and it was decided that meetings should be split into two sections—one to deal with locality records and one to study a previously announced genus or species. The sixteenth meeting, 4 June, records the first original paper read to the Club—one by J. W. Taylor on *Helix caperata.* At the following meeting, Roebuck resigned the secretaryship to the general regret, and Crowther took over. On 26 July the minutes record that '. . . A Paper was read by Mr. Hy. Pollard on the Solenidae, a pretty long and exhaustive paper which, altho' lacking somewhat in technical character, eliminated facts of interest to the members.' It is hoped that 'elicited' was meant. The minutes do occasionally expose opinions but the meetings themselves seem to have been held with great formality, although average attendance continued to be between four and five. Papers became a regular feature, but there seems to have been little thought of actually publishing them.

It was a red-letter day for the Society when, on 20 September 1877 they recorded the presence of Robert Scharff (1858–1934) as a visitor. He joined the Club on 18 October and presented it with 'A book and a shell' on 1 November.

The enthusiastic and generous Scharff contributed largely to the collections and the library, became treasurer for a while before going abroad, took office as president in 1903–4, later becoming Director of the Dublin Museum. He seemed to infuse the Society with something of his own ebullience, and the minutes refer to him as a liberal donor, open hearted friend and generous giver to the collections.

Early Organization. Review of the Club's progress after a year brought some far sighted remarks from Crowther. Scharff's gifts had made it evident that the Club 'was not constituted to receive them'. It needed a broader basis, and being the only one of its kind, should consider fulfilling the need for a national society. They should raise the subscription and establish the library and collection. Accordingly, the Club thenceforward became the Conchological Society, with a subcription of 10s. 6d. together with a reduced rate for existing members; presidency was to be for one year. Another step was taken on 17 January 1878, when it was decided to adopt the *Quarterly Journal of Conchology* as its official organ; members would be entitled to receive this, there would be a proposal form for membership, and books owned by the Society might be borrowed by members. Otto Semper of Hamburg wrote that he desired membership and enclosed a subscription; this was accepted, and he became the first foreign member. On 21 February 1878 it was resolved to elect a curator (Nelson was chosen), and to print a form of election notification. Several names which have passed into history now make their appearance on the listing: William Cash of Halifax, Bryce Wright the dealer, Alfred Leicester, Dr. W. Hill Evans, J. Darker Buttrell, Sherriff Tye, Cosmo Melville, Edward Collier, John Brazier of Sydney. The principle of Hon. membership was accepted and Dr. Kobelt of Frankfurt was elected the first on 9 May 1878. Scharff departed for an appointment at Bordeaux accompanied by a valedictory vote of thanks for 'the very great obligations he had conferred upon the Society'. New rules were adopted the same year, the name was changed for the last time and became as it now is; objects, memberships and fees were defined; there was to be a governing Council and up to ten honorary members, meetings to be held in Leeds, three to form a quorum; accounts passable at a December A.G.M., capital to be vested in two trustees, proceedings to be published periodically. Thus was born in almost every respect the Society as we now know it. However, although shells were sent for exhibition, attendance at meetings did not rise. For the time being Crowther drops out of the scene completely on leaving Leeds.

The first ever committee meeting as such was held 5 February 1880, before the 54th ordinary meeting—previously every member had pretty well been an officer. The official organ, the *Journal of Conchology,* remained out of the Society's control. Charles Ashford commenced a long period of close co-operation, submitting papers, sending gifts and exhibition material, but never joining up. Subscriptions were determined annually according to the needs of the budget. By December 1880 there were twenty-five members. Roebuck, as recorder of Yorkshire localities, made a report; he had 1100 records for 128 varieties, and a

little later he was proposing an improved recording system. The Recorder was now an officer of the Society: the basis of his scheme was that 'every statement . . . shall have been vouched for by the actual exhibition of a specimen to competent judges' (Report, 1882). The Society may indeed feel thankful for the far-sightedness of its founders and the high standards they enjoined right from the start.

Soon it became essential for the recording scheme to be extended to cover the whole of the British Isles, and the vice-county scheme already worked by the Botanists was adopted. The recorder suggested the publication of county lists and the need for a new and revised list of British non-marine Mollusca, an older list compiled by Taylor and Nelson being out of print. The list duly appeared in the *Journal,* vol. 4, No. 2, 1883.

The Monograph of the British non-marine Mollusca must have long been Taylor's dream and the motive behind much of his activity. A little advertisement now appeared on the back cover of the *Journal* announcing that it was 'in preparation' and appealing for information on the particular genus he was working on at the time. The announcements continued for years with varying details and occasional little notes like the plaintive 'Where did Layard describe *Testacella aurigaster*? Mr. Layard himself has now forgot'. T. W. Bell, now Hon. Sec., writes minutes which are less helpful to the researcher than those of either his predecessor or his successor, omitting as he does place of meeting, those present, and the strength of the Society, but it seems evident that meetings were now being held at the Leeds Mechanics Institute at a rent of a shilling a time. At the meeting of February 1884 it was resolved that a rule be added to the constitution allowing members the privilege of adding MCS after their names.

Further progress is cheerfully reported for 1885. There was a public exhibition of shells in Manchester to mark the opening of a new suite of rooms at the Lit. and Phil. Society, George Street, the first record of any concerted action by the Lancashire members of the Society. The first Census was published in the *Journal* Vol. 4 No. 10, consisting of a list of shells with county numbers printed opposite each: an excellent start by Roebuck. A British Marine list compiled by A. Somerville was officially adopted by the Society; Taylor also commenced an album of conchologists, appealed for, and obtained, photographs from most of the members.

The 125th meeting, 4 February 1886, was a memorable one, bringing as it did membership applications from J. R. le B. Tomlin, E. A. Smith, G. B. Sowerby, Thos. Rogers and B. B. Woodward. Von Martens and Bourguignat were elected to honorary membership soon after.

Voting papers were first issued for the convenience of members in November of the same year, printed with the Council recommendations for next year's officers and council. In addition to council members, four vice-presidents were to be elected, and this practice continued for many years: the distinction to be drawn between the two classes is not clear. Three committees of reference were set up for British Marine, British Non-marine and Exotic respectively, to which all nomenclatural questions might be referred. Referees were to submit decisions

through the Council. This set-up appears, partly at least, a by-product of the continuing preoccupation with varietal names.

At the A.G.M. of 1887 nominations for officers and council were first positively solicited instead of recommended, and it was ruled that voting should be by ballot in sealed envelope; the Society was formulating its machinery. All papers read were to be submitted to referees who would advise Council: the name of the referee was usually appended when the paper appeared in print. The office of Curator, to be a Council member, was created.

The Manchester Organization. 1888 was a fateful year for the Society. In February a group of members met together and resolved to form a 'Manchester Conchological Society', a branch of the main Society, and a deputation consisting of Darbishire, Collier and Standen (who later became the first president, treasurer and secretary of the branch respectively), went to Leeds to find out how this might be done. The matter was considered at the April Council meeting, at which resolutions were passed bearing on the formation of branches and local groups in general, and taking care to tie them to the parent body. Action was confirmed at the A.G.M. and the Manchester Branch commenced its own minute book—which survives. At the same A.G.M. it is recorded that 'Correspondence was brought forward from several members, five of whom resigned their membership'. This correspondence has not survived, but C. P. Castell (in note 3 December 1962) was of the opinion that this dissatisfaction was what led to the formation of the Malacological Society of London, as a splinter group.

The venue for meetings was changed because the Society's room at the Mechanics' Institute had become too small. It may be inferred that although membership rose steadily, attendance at meetings (except the A.G.M.) continued at from four to six. The library and collection had been growing rapidly and the acquisition of three new cabinets (one 'for types'), caused the Society to take a new room in the Philosophical Hall, Park Row, part of the Leeds City Museum building.

There was a publication crisis. The *Journal,* although it published the Society's papers and minutes, belonged to Taylor, was edited and published by him, and contained many items submitted to him directly. It was in no way under control of the Council, and journals and books sent to the Editor on an exchange basis were naturally retained by Taylor. Much discussion went into the arrangements which followed, making the *Journal* into the Society's official organ and agreeing on a proper basis for payment to Taylor, who continued to publish papers not submitted to the Society.

A portrait of J. G. Jeffreys, painted in oils by Mrs. Skilton of Brentford, was presented.

It does not seem that all was well, although no private correspondence has survived to tell us the nature of the malaise. One or two Council meetings seem to have been terminated by someone leaving at an early stage, thus denying the meeting a quorum: a joint letter from Cooke, Hoyle, E. A. Smith and Sowerby

was read at the Council meeting of 3 April 1889 resigning their positions on the Council: the problem seems to have been concerned with the adoption of resolutions in the absence of some of the council members, and without anything indicated on the agenda. The matter seems to have been smoothed over, and whether it affected Bell's position in any way we do not know, but we find Roebuck replacing him as Hon. Secretary soon after. An immense amount of anxious discussion followed the discovery that a Mr. Williams, in submitting papers for the *Journal,* had given himself university qualifications to which he was not entitled. Most of a council meeting was taken up with deciding that he should not have been told that there was to be a council meeting about him. The resolution to drum him out of the Society was forestalled by his resignation, and it was resolved that his papers not be read.

A list of members (180 names) and constitution was published, and with Roebuck as Hon. Secretary, full accounts of meetings were sent to the *Leeds Mercury* and *Yorkshire Evening Post,* who were always happy to publish ten or twelve column-inches of closely printed proceedings, the compositors coping manfully with handwritten notes involving latin names and technical terms they had never heard of; the results are frequently curious. Furthermore, the Council determined that any member submitting a paper or exhibit at a meeting was entitled to be sent a copy of the newspaper containing the report.

L. E. Adams, the new Hon. Treasurer, sounded a warning about the growing number of unpaid subscriptions. Discontent with the *Journal* may be inferred by the decision of the Manchester members to have their papers bound at intervals for general use instead of being submitted for publication; and possibly by the founding of a new Journal, the *Conchologist,* later renamed the *Journal of Malacology,* by W. E. Collinge, who was a member, and who also compiled a library catalogue of the Society's books in April 1891.

At the April meeting of that year the members present (all three of them founder members) stood to arms on hearing of a letter from J. R. Bourguignat, Hon. Member, informing the Society that it was his intention to take Lang, 1722, as his nomenclatural starting point and to ignore Linné. No more was heard of this, Bourguignat dying shortly afterwards. There was however, a proposal that instead of so many summer meetings there should be a conchological conference, to be held in a different place each year. Cockerell's new 'British List' received severe criticism from the Manchester Branch, who thought it contained far too many varieties and was confusing and valueless.

An autograph collection was commenced, and a new Society list of land and freshwater Mollusca issued: this was compiled by Nelson, Roebuck and Taylor as a foundation for all future work. In view of the critical reception of Cockerell's list, they were much exercised to know how best to treat the problem of named varieties.

The errant Crowther rejoined the Society in May 1893, on his return to Leeds as curator of the Museum, and was seen at most of the meetings; about this time too, a circular appeared, signed by many eminent conchologists living in the

south canvassing support for a London Conchological Society. Change was in the air and there seem to have been many who regarded it as essential, despite the good work which was undoubtedly being done. The meetings of the parent Society throughout the early nineties were attended by nobody except the founder members, and few or no field meetings seem to have been held. The Manchester branch, on the other hand, existed largely for field trips, and the ordinary meetings too could count on an attendance of eight to twelve. The membership was now growing very slowly and irregularly, and the Manchester branch had reason to write a protest to Leeds about the irregular appearance of the *Journal*. There was a financial crisis owing to the number of unpaid subscriptions. Adams was apparently having continuing difficulty in getting in the money: some people hadn't paid for up to nine years and some had never paid at all! All were still receiving the *Journal*.

The Council cannot be accused of inactivity. They directed that the *Journal* be sent only to paid-up members and that others be warned after three years: learning that Nelson, with five years' arrears was among the sinners, they remitted his debt and made him an honorary member: they also negotiated with J. W. Taylor to buy outright the goodwill, copyright and back numbers of the *Journal* for a consideration of £30 (there were about 7000 back numbers). The Council then turned its attention to a suggestion (which came, be it noted, from Leeds members), that the headquarters of the Society should be moved to Manchester, of which the Leeds organization would become a branch, and a meeting was also held in the Borough Road Polytechnic, London, under the chairmanship of the Rev. Canon J. W. Horsley, Rector of Walworth, to consider the formation of a London Branch.

The Transfer of Headquarters. In 1895 it all happened, but not without a great deal of argument. The *Journal* was transferred by Taylor to the Society and although he continued to print it, W. E. Hoyle took over as Editor, an editorial committee of three was elected and Dulau and Co. were appointed agents. The Society headquarters became centred in Manchester, the 239th meeting being held at Owens College on 3 July. The library and collections were moved, but there was something of an impasse when Roebuck refused to hand over the Census notebooks to Thomas Rogers the new recorder, insisting that they were his private property and required for the purposes of Taylor's Monograph. They finally arrived in Manchester in October 1900.

Roebuck, who could not now regularly attend, was made 'Hon. Secretary Emeritus' which enabled his name to appear thenceforward among the Society's officers. Twenty one new members joined all at once. The London branch, with Horsley as its driving force, organized itself and had its first meeting on 10 January 1896. L. O. Grocock as Hon. Branch Secretary very soon handed over to J. E. Cooper, who continued in office for many years.

The Yorkshire Branch, as it had now become, were careful to make it clear that although a branch, they were also an organization completely independent

of the parent society; in this way they were merely following the lead of the old Lancashire Branch in trying to get the best of both worlds. Crowther for one disapproved of the goings-on and resigned from the Society for the second time, being immediately elected President of the Yorkshire Branch. There was a comb-out of members, quite a number were struck off for non-payment and their names published, as the custom then was. No doubt it was greatly to Adams' relief; his audited accounts were running two years behind and his powers up to then had evidently been inadequate. Members protested, however, about their debts being notified to them on postcards.

It was in this year too, that the first part of Taylor's great Monograph was at last issued and received the favourable reviews which were its due.

The Society's work continued peacefully into the new century. Monthly meetings were held except in July and August, and attendance was about a dozen. Crowther rejoined for the third time. The large deficit of £60 was paid off by members' donations. At the suggestion of Boycott a Committee for Collective Investigation was convened at the 1900 A.G.M. to study variation and life history of non-marine Mollusca. Possibly its terms were too vague; it was to be ill-fated. The following year saw the issue (in *J. Conch.* 10:9) of the first British marine list, compiled by a committee of which Hoyle was the secretary. A strange body called the Conchological Exchange Club was formed jointly by the Society, by its member Collinge as Editor of the *Journal of Malacology,* and by the Midland Malacological Society.

As always, there were disagreements. A paper by L. St. George Byne was very much reduced and cut about by the referees and he promptly sent in his resignation, which was as promptly rejected by the Council on the grounds that it was based on an incorrect supposition. The matter was smoothed over.

In 1903 the A.G.M. was held in Dublin, the first recorded Irish meeting. A dozen people attended, but it seems that only Hoyle travelled over from Great Britain for the purpose. The Land and Freshwater List of 1892 compiled by Taylor and Roebuck was now out of print, and B. B. Woodward offered the Society an alternative compiled by himself. His ideas however, were unorthodox in the context of his time—he had for instance rigidly excluded all the varieties beloved by most of his contemporaries. The Council therefore considered the list unacceptable and adopted the typically British compromise of creating a committee to consider the needful changes. L. E. Adams and Standen added varieties to the list as it stood, and it came out in 1904.

Throughout this decade, the work of the Council consisted almost entirely in passing papers for presentation to the Society: passing accounts for payment: and considering cases of members in arrears, of which there continued to be many, probably because there was no regular reminder system in operation and only when the time came after three years of default was the member told about it. The sum involved was then a big one, but the Council established more or less that a member was actionable for its recovery until such time as he formally resigned. All expulsions were made public to the membership.

1906 brought the death of William Nelson, first of the original members to go. A poor man, working at his trade all his life, he had it seems never been able to make provision for his old age and had been in failing health for some time. In January a rather pathetic slip of paper was included in the *Journal,* an appeal for financial help by some of the Leeds members headed 'The Nelson Relief Fund' to save the crippled old man from indigence and the shadow of the workhouse: however, by the 28th of the month he was dead.

The Editor was created a member of the Council that year, Tomlin took the job, and this was the start of a forty-year era. A library catalogue was issued as *J. Conch.* 12, No. 4, in an attempt to popularize among the members the rather under-used amenity.

It may be noted that there was considerable talk of pollution in the Edwardian years, particularly the poisoning of rivers, and in 1908 the Society vigorously supported action to initiate legislation on the matter.

In 1910 one of the Rules was amended to allow ex-presidents to become vice-presidents, but the latter continued to be elected also. The Society's formation date started to appear, by resolution, on the cover of the Journal; the Librarian became ex-officio a member of the Malacological Society.

The branches had been carrying on in a rather small way with both indoor and field meetings, but attendance seemed rather poor and neither branch appeared really to flourish. They were, however, joined in 1913 by the forming of a third, the North Staffordshire Branch. This year too it was resolved that an autograph collection of notable conchologists should be commenced. The Society still possesses quite a large autograph collection, but there is no knowing whether it is the original one.

Kennard and Woodward came up with a thoroughly revised non-marine list which they offered to Council to supersede the one in use. The Council tended to think that it raised more questions than it settled, and declined to adopt it.

The coming of the War in August 1914 did not outwardly make much difference to the routine of the Society, although no A.G.M. was held in 1915 and rising prices spurred the Council to ask of the Hon. Treasurer, Bostock, the reason for a two-year wait for a balance sheet. J. W. Taylor was presented with an illuminated address on the occasion of his seventieth birthday, for which purpose a special general meeting was convened on 6 February 1915.

An emphatic official protest was entered by the Society against the government decision to close all the museums and art galleries; and an example of the tantalising nature of the old records occurs in the Council minutes of 12 April 1916, which consist entirely in the remark 'The resignation of Mr. Platt was considered and it was decided to ask him to reconsider it'.

The North Staffs. Branch had to go into abeyance, but Roebuck, ably assisted by Boycott, was putting an enormous amount of work into getting out the Non-marine Census, and it was decided to call for subscriptions to cover the cost. Less satisfactory were the accounts, and Council dissatisfaction was expressed at Bostock's delay in getting out a statement and not drawing attention to a £24

adverse balance nor preventing 84 members from getting three or more years in arrears without cutting off their publications or, apparently, notifying them.

A Journal committee of three was created to assist the Editor Tomlin, at his especial request. It was resolved at about the same time that fees received in respect of life membership should be paid into a separate fund; this was in effect the start of what is now called the Research and Reserve Fund.

The end of the war, with its attendant inflation, increased the Society's outgoings, and continued anxiety about the financial situation spurred Boycott to insist on paying anonymously the complete cost of printing his presidential address. Methods of cheapening the *Journal* printing were discussed with J. W. Taylor, and the Council ruled that lengthy contributions would have to be drastically pruned or the contributor required to pay towards the cost. This caused some protests, notably an emphatic one from Harry Beeston who considered that science might suffer—also that he was being discriminated against.

In 1919, after much heart-searching, it was decided to double the annual subscription to ten shillings for new members, others paying at either old or new rate according to their ability and inclination. This was the year of Roebuck's death and the new Census had not yet been published. Boycott agreed to complete the work which he had latterly been sharing with Roebuck, but many of the records could not then be found, in particular those listing vice-county populations for each species, the returns of county lists which used to be provided to people going on holiday, nor the bound volume of distribution maps. J. W. Jackson, the Hon. Secretary, was evidently unable to help, but all must have been straightened out in the end because the Census appeared as the Roebuck Memorial Number of the *Journal,* Vol. 16 Nos. 5–6, and pointed the way to modern methods of data collection. Roebuck had spent nearly fifty years collecting the data for it, but in form and scope it was Boycott's, who continued as recorder until his death in 1938.

The North Staffordshire Branch was revived on the return of its officers from war service, although for the time being it appears mainly to have been a correspondence club. Cooper, after twenty six years as Hon. Sec. of the London Branch, resigned in favour of J. C. Dacie and meetings for the next few years were held at his office address, 10 Bush Lane, Cannon Street, EC4. Kennard was president throughout the twenties and thirties.

1922 saw the affiliation of the Society to the British Council and the commencement of its annual contributions to the Mollusca section of the Zoological Record. McClelland commenced compiling his 'Index' with Council support; this was a useful listing of all families, genera and species described in *J. Conch,* vols 1–16, the *Proc. Mal. Soc. Lond.* vols. 1–15, the *Conchologist* and the *Journal of Malacology.*

It was now that Tomlin suggested the practicability of a marine census along the line of that existing for non-marine species. He proposed that it should be based on Winckworth's List and Winckworth agreed to work out details. One immediate result was the creation of the office of Marine Recorder (1924), but

a year later all that Winckworth had to report was a complete lack of interest.

The Leeds Branch seems to have been in deep water for a while, uncertain of their constitution or their relationship with the parent body, to which many of their members did not belong. There were those among them who considered that they remained the senior society, but their arguments must have introduced an air of unreality rather unfitted to the hard-headed Yorkshiremen. The Leeds Branch, or Leeds Conchological Club, changed its name to the slightly unwieldy title of the Yorkshire Conchological Society, the Yorkshire Branch of the Conchological Society of Great Britain and Ireland. The local Hon. Secretary, Fred Booth resigned after twenty years service.

Continued rises in printing costs resulted in the inauguration of an illustrations fund, to which generous members might contribute to help things along.

In 1926 Tomlin wrote to Taylor of his intention to leave his collection to the National Museum of Wales and also asked him to write the history of the Society's first fifty years. Taylor replied that Jackson was engaged on this, whereupon Boycott wrote to Jackson instructing him that his (Boycott's) name was not to be connected in any way with the Census scheme, his part in it being infinitesimal compared with Roebuck's.

H. H. Bloomer in 1929 brought forward a suggestion that there should be a research fund, and offered the large sum of £100 to start it off. The suggestion was adopted with enthusiasm and C. Oldham anonymously added another £100. However, interest in marine recordings was still almost entirely lacking.

G. L. Wilkins was elected Hon. Secretary of the London branch in the same year, succeeding the late J. C. Dacie. Meetings were held at the Cripplegate Institution, Golden Lane, EC4 and Kennard remained president till the war. Attendance was usually small, rarely more than five or six, but consisted entirely of such top-flight people as Blok, Boycott, Cooper, Crawford, Kennard, Peile, Wilkins and Winckworth. The branch was loosely organized, as was the North Staffordshire branch, with a minimum of constitution, so that all its time could be spent on the pleasures of conchology. Ten minutes once a year were enough for the business of the A.G.M. There are no records of field meetings, although a few must have been held.

In 1927 the Society had the frustrating experience of having to decline a substantial bequest from P. E. Radley because of the conditions attached: the Malacological Society also refused. The North Staffordshire branch ceased to report in 1931 and this year too marked the passing of an era with the death of J. W. Taylor, more than anyone the founder of the Society, who had as elder statesman guided it with exceptional wisdom and charm for fifty six years. His books, collections and cabinets were presented to the Society, which was thus enabled to carry on the work which he had so soundly begun. Boycott, through whose influence this was done, put forward a scheme for completing the great Monograph by joint committee, but in spite of considerable efforts, this was never achieved. Nobody but Taylor could do Taylor's work.

The List of Marine Mollusca—the Winckworth List which to a great extent

we still use, came out in 1932, a thousand copies of the separate were put in stock, and the work of those who were interested in marine Mollusca was both channelled and made easier.

Progress through the thirties was on more sophisticated lines than before, and no longer were lists of local shells with comments so often published in the Journal; they were handed direct to the Recorders, and ecological and systematic matter occupied more of the space. Arguments concerning named varieties decreased to vanishing point as conchologists rearranged their priorities. The status and constitution of the Society, and indeed its membership, remained largely unchanged, progress was steady rather than spectacular, and the main duties of a largely carefree council consisted as before in passing accounts for payment, approving papers for reading at meetings and dealing with cases of members in arrears; with none of these matters does the Council now normally concern itself.

Taylor Brothers ceased to print the *Journal* in 1934; after all, there was now no sentimental attachment to the old firm (which closed down soon after), and their prices were above those of Stephen Austin of Hertford. Yet again was a publications committee formed to guide and assist the Editor Tomlin, although there is no record that it was any more effective than its predecessors. Most meetings continued to be held in Manchester, but most years there was a Lancashire-Yorkshire meeting held at Leeds and the A.G.M. several times took place at Burlington House. Dulau resigned the agency for the sale of publications and David Nutt was appointed instead.

Field meetings seemed to suffer a further decline in popularity and such as did occur have remained unrecorded; only one was planned for 1935 for instance, and that was cancelled because of bad weather. The London branch never had much use for them, and although the Leeds branch always tried to organize a few, they seem to have yielded meagre results.

The meeting minutes had by now adopted their present form, but amendments to the Rules were still required at intervals, as they always will be. At a Special Meeting in October 1936 for instance, Tomlin got approval for the present rule that the presidency should be tenable for two years in succession and the president was expected to give an address. No harm in expecting, of course but the next president, Peile, declined to comply. At that time too, an application from the Zoological Museum of Amsterdam decided the Council to introduce institutional membership—previously an institution had had to join in the name of one of its members.

A crisis, one of several, arose in connection with the library. The Council was told that it was overflowing its accommodation, many of the books were in bad condition and it was not much used. Jackson brought up the matter strongly in 1937 and again in 1941, suggesting that the library should be merged with that of the Manchester Literary and Philosophical Society. Control could be retained, usage and maintenance could be improved. The Trustees however, would have none of it and the library, never used to any extent, continued on its long decline.

Crowther, the last of the founder members, died in 1937 and his brain-child,

the Yorkshire Conchological Society, found itself in low water with undischarged debts and no money.

1938 the parent Society took part in the 150th anniversary celebrations of the Linnean Society and in this year too, R. Waterston, non-marine Recorder, came up with proposals for a revised census. Council supported action but it was felt that a revised check list should come first. Kennard's list, with its Taylorian varieties, did not find approval and Kennard was asked to provide a new and simplified version. Nobody guessed that the proposed census was still fourteen years from publication.

Wartime. Immediately on the outbreak of war in 1939 the ill-fated library was removed from its room in the lower reaches of the Manchester Museum, now urgently needed for a public air raid shelter, and stored in a damp cellar and in many other odd corners. It thus became immediately unsortable, even had there been anybody to do the job. Jackson, who had been unable to plan for, or supervise, the move said prophetically 'we shall never get it straight again' and kept on saying that it should go, although almost nobody heeded him. No meetings were held between the War Emergency A.G.M. of 24 November 1939, at which A. E. Salisbury was elected Hon. Treasurer, and the Annual Meeting of 8 February 1941 at which it was at long last decided that members one year in arrears should not receive publications. By resolution all work on the census was postponed till after the war and at the next A.G.M., 14 November 1941, A. E. Ellis, on vacating the presidential chair was elected a vice-president 'ex officio'. This was probably not the first case but paved the way to the present vice-presidential arrangement.

Except for isolated meetings in 1943, activity in Manchester was at a standstill during the war, although the Yorkshire branch seem to have continued to be fairly active. There were occasional meetings, regarded as of the parent Society, in London, in the British Museum (N.H.), which seemed rather indicative of a drift to the south, but 1944 and 1945 each produced nothing but a small A.G.M., one held at the Linnean Society and one at the Natural History Museum.

W. Thurgood, an energetic Leeds member, offered to try and sort out the library if it were moved to Leeds. Jackson, still Hon. Secretary, agreed, but the uncertainty about the postwar position resulted in a further two years' delay in getting anything done. Thurgood also analysed the distribution of the members and found that the vast majority in England lived south of Leicester; he pressed the Society to establish its postwar headquarters in London. Jackson was retiring anyway and intended to resign the secretaryship. After a scheme to hold meetings in rotation at Leeds, Manchester and London had been reviewed, the new Hon. Secretary, Mrs. McMillan, made arrangements for the 1946 session to be held at the British Museum (N.H.), starting with the May meeting. In this matter Tomlin found himself at odds with the Council; he considered the step was a false one, since the Malacological Society was already in London.

Our Society found itself financially in very low water. Membership had dropped

by 25% and in spite of very little having been done, the postwar inflation imposed a rise in the subscription to £1.00.

The library move took place in September 1947. Books and papers were gathered seemingly from all over the Manchester Museum, and arrived in Leeds in a confused, torn and dirty state. There were many interruptions and arguments, and the removers had to return twice for inaccessible or forgotten material; the final bill came to £35.15.6. Thurgood, as librarian/curator, then addressed himself to the task of reducing everything to order, discovering as time went on that this was largely impossible in the accommodation available, which hardly gave him space to enter the room, let alone to move stuff about and stack it neatly. He started by sorting out a vast amount of non-conchological books and periodicals received in exchange. Many back-issues of our Journals were disposed of at this time too, and Thurgood was for long anxious about the archives, which hadn't turned up. He was eventually able to disinter most of them and sent the Census books to Ellis, who was now non-marine recorder as well as editor.

Maintaining its reputation as a guardian of the environment, the Society sent a letter of protest to the War Office about the decision to retain Braunton Burrows as a military practice locality; and in 1948 also (3 October) occurred what was probably the most memorable of the Ordinary meetings, no. 686, when members were invited to Yattenden Court, Berkshire, to view the very fine collections of Lady Iliffe. The meeting, held jointly with the Malacological Society, was under the polished chairmanship of Blok, a recital on the magnificent organ was given by Salisbury who was a gifted musician, and Lady Iliffe was elected a member by acclamation—the only occasion on which such a thing has been done. She remained a member for nearly twenty five years.

Work was resumed on the issue of the revised Census: a Royal Society grant of £50 was received, but the remainder of the £200 cost could not be covered by the Research and Reserve fund. The British Museum were asked to publish it as one of their Bulletins and declined; it was finally issued as a double number of the *Journal*, vol. 23, Nos. 6–7.

Thurgood died in early December, and there remained nobody but Mrs. Thurgood available to sort out back numbers etc., required by members and others. The library continued to deteriorate, in spite of long hours she spent there, and for which she was elected to membership at no cost to herself. Her health was bad, and she asked to be relieved of her self-imposed but important task; the Council found itself helpless.

1950 brought the first syllabus folder, issued to all members living in the U.K. The idea came from G. L. Wilkins, and it was probably he more than any other who, as Hon. Secretary of the London branch, succeeded in keeping the Society alive throughout the war years. The Council ruled that ex-enemy members could rejoin by reapplying.

Mrs. Thurgood was able to do some sorting in the library as time went on, but queries became more insistent about the use to which it was being put. A large body of opinion regarded both the library and the agency as useless liabilities.

Official permission was received by the Society to quote the British Museum (N.H.) as its Headquarters, and at the December Council meeting, 1951, it was resolved that 'The prewar practice of submitting all papers to a Publications Committee before being read should be revived'. The new committee was determined as consisting of the four principal officers or the Council as a whole, and seems to have had no duties unless invoked by the editor Ellis. A new set of rules was drafted and adopted at a S.G.M. in February 1952; they were basically as they are now.

The marine recording system continued to arouse little or no interest then, or for many years to come. In 1953 the serious illness of Mrs. Thurgood forced the Council into action on the matter of the collections and library. It did not take long to make arrangements for the former to be transferred to the British Museum (N.H.) on 'permanent loan'—a term of fairly precise legal significance; but the library was a different matter. At a special meeting in February the Council asked for powers to act freely and this the meeting refused to give them, requiring more specific proposals to be put forward at a future meeting.

This proved difficult. The Trustees were heavily involved. Detailed advice as regards the legal position was provided by J. F. M. de Bartolomé, who was (and is) our Hon. legal adviser, and who went to a great deal of trouble to determine the consequences, particularly to the Trustees (Hopwood and Quick), of selling items received as free gifts for the perpetual use of members. Last minute efforts to find alternative accommodation failed, and at a special meeting of 20 February 1954 it was agreed 'that the library be sold and the proceeds of the sale be invested, the income to be paid into the general funds . . .' Although this was passed *nem. con.*, there were both doubts and fierce opposition as the surviving correspondence shows; however, Leeds Museum needed their room badly, Wheldon & Wesley the booksellers agreed to act, brought the whole of the material to London, separated out the *Journal* back stocks and made an offer of £800 for the remainder, which was accepted. Ellis, realizing that most of Taylor's notebooks were incorporated in the library, had them rescued at the last minute and lodged with the collections, where they now are. All exchanges of literature with other bodies were cancelled, and this had the effect of bringing in some institutional members.

Ballot slips were instituted for voting the acceptance of new members, but it was never established whether a single 'anti' vote would reject an applicant or whether a simple majority was enough to secure his acceptance. The North Staffordshire branch had by this time dwindled to two and had to be regarded as 'in abeyance'.

The late fifties provided a period of peaceful consolidation, and a great deal of useful work was done. The Hon. Secretary, C. P. Castell, was employed at the British Museum (Nat. Hist.), and with his gentle influence the Society enjoyed the privilege of meeting in the Boardroom, being provided with storage for its records and being allowed access to the library and collections on the mornings of meeting days, all treasured amenities later to be somewhat brusquely withdrawn

under changed circumstances. Very few field meetings were held during those days and it was usual for small groups of members to make their own private arrangements for such excursions. The Society's one remaining branch, that centred in Leeds, was a cause of concern when it was discovered that practically nobody in it belonged to the parent society, and it was consequently moved that its reports be not read.

The first suggestion of a European Malacological Conference was made at the 25th anniversary celebrations of the Netherlands Malacological Society, at which we were represented by S. P. Dance. This was in 1959, and the Council started arrangements at once.

Colour-slide talks, which have been such a welcome feature of many of our recent meetings, were inaugurated by a lecture of Biological Research in the shallow seas, by W. Rees. C. A. Raffray, now Hon. Treasurer, notified Council that he could find no account of stocks or cash held by the Agent, David Nutt, for some years past, nor could he obtain any response from the firm; the money involved was considerable. The combined efforts of the Society's officers were unable to influence the situation, although Raffray was able to establish that the proprietor and sole member of the firm was extremely aged and probably incapable of running a business. All alternatives having been exhausted, we were forced to sue in the interests of our members. The case dragged on until 1961 and was finally settled in the Society's favour in the sum of £220 plus costs. It was then agreed that we had no further need for an agent.

An attractive prospectus designed by Castell was issued to provide both information and application form for interested non-members. Wisely, it incorporated a copy of the rules.

At this time also, the Society reviewed its printing arrangements. Stephen Austin of Hertford, our printer for many years, is a large concern, and it was felt that our own rather small needs were to some extent being neglected. It was agreed to change, and after a consideration of three tenders the Council decided to award the contract to Bennett of Salisbury. This firm commenced well, but the Journal is a specialized piece of printing and within two years the Editor Ellis had reason to complain of the quality of the work.

The concept of the Conchologists' Newsletter had been receiving some consideration and in 1961 M. Goodchild undertook the task of bringing it out on a quarterly basis. It was to be primarily for ephemera, general information and discussion, field meeting arrangements and reports, wants, exchanges, experiences and the like, and it was felt that properly produced it could do much to popularise the study of conchology. In the upshot, the Council's forecasts in the matter were abundantly justified.

The same year brought trouble for some of the officers. The tax authorities suddenly put in a large claim for income tax on the subscriptions received for the previous seven years. The Hon. Treasurer, always a fighter, succeeded in rebutting the claim, but it was clear that constitutional changes were essential to prevent further demands of the kind. About the same time the Council was made aware

that its senior trustee was proving unco-operative, both declining to act on the Society's behalf, and retaining monies which should have been passed on to the Treasurer.

Another example of the unexpected but major difficulties which can face an honorary officer appeared at Christmas time in 1961, when the whole of the copy for an issue of the Journal disappeared, probably in a stolen mailbag in transit between the Editor and printer.

Reorganization. It was now that the non-marine Recorder, M. P. Kerney, advocated that the Society should adopt the national grid of 10 km. squares as a basis for a major refinement in the recording system. This proposal was agreed to with some enthusiasm and with results which have perhaps been more favourable than anyone could have forseen, and which have certainly put this Society in the forefront in this type of research.

1962 was the year of the first European Malacological Congress, held in London after years of work on the part of its Hon. Secretary, H. E. J. Biggs, and a team of volunteers. The Society shouldered its full burden of the work and a sturdy growth, the European Malacological Union, resulted.

In October an important special meeting was held bearing on the trusteeship and amending the rules to allow the Society to be registered as a charity. The help of the Charity Commissioners was made available and we were secured against income tax claims. The resources of the Society were now seen to be to the academic benefit of all and the financial benefit of none.

Field meetings were gaining rapidly in popularity and we now created the position of Field Meeting Organizer, for which T. Pain volunteered his services and has so continued ever since. Another Council decision at this time decreed incredibly that notice of agenda for each meeting should be sent regularly to all members requiring it: there were no takers.

In 1963 a group of members indicated dissatisfaction with the Council, and submitted a somewhat rambling document indicating a need for further changes in the constitution. Procedural rules for Societies make it clear that changes in the rules must be drafted by Council or subcommittee which alone can receive proposals; the changes are then voted on as they stand at a special meeting which may accept or reject but may not vote on amendments. The new rules had been duly adopted by these means but not to the satisfaction of the dissidents, who were expecting a full debate and many resolutions, and who had therefore not seen the need to make full recommendations to the council beforehand. The basis of the objection, as far as could be determined, was mainly a fear that the Society might come to be ruled by a clique of elderly vice-presidents who would not have its interests at heart. Measures to provide against this dreadful contingency were eventually incorporated into the cumbersome wording of rule 15, although it is doubtful if more than four vice-presidents are ever likely to gather together. This was done at a special meeting in February 1964, needed principally to include in the constitution the newly created Junior Section, the responsibility for which

was undertaken by Biggs from the start until his death in 1973. The issue of papers for students commenced at once.

Trouble was growing between Editor and printer, some of the printing being done in slovenly fashion on worn-out type, and promises were not kept. Ellis advocated a change, and in 1965 the work was taken over by Edward O. Beck of Villiers Street, Strand, to coincide with the change of editor. Printing quality improved, but as D. Heppell the new editor was stationed in Scotland it was thought good to have a London based member as liaison to deliver material and instructions personally to the printer. In the upshot, this work soon began to be neglected seriously, and since no information was available on the position, it was some time before the Council found out exactly what was going wrong. By that time the *Journal* was some months in arrears, a position which was not put right for a considerable time.

1965 was a difficult year altogether. The subscription had to be raised for the first time for many years and now stood at £2. This was entirely due to the pressure of economic events, since management was most frugally carried out and the Council had fought hard against the surcharge. Also, regrettably, it found itself again involved in a legal dispute on behalf of the members after the senior trustee had since 1961 ignored all requests to deliver up the Society's property. Honorary officers of an organization such as ours do not normally expect their work to involve the conduct of lawsuits, but this was the second time that the secretary and treasurer had to undertake this distasteful work, and the case was again a pathetic one arising at least partially out of the great age of the defendant. Bartolomé, as legal adviser, made it clear to us that Trustees are in a remarkable and unique legal position and it is an extremely difficult thing in law to sack a trustee who does not want to go; the Society would have to face certain difficulties of its own unwitting creation and would even need to tread on unexplored legal ground. In the upshot, after a considerable delay a court order was granted and the Society recovered its dues.

The housing of *Journal* back numbers had always been a problem, and printers are usually short both of space and of time to look out and send off back number orders. In 1966 therefore, arrangements were made with the Johnson Reprint Company to take over back stocks for an agreed sum for future sale—with a reduced rate for members—and to reproduce numbers which were out of print.

The Non-marine Census list supplement was issued this year and interest in both census schemes remained at a very high level, under the enthusiastic guidance of Kerney and Mrs. M. Turk respectively. 1967 brought both a newly designed and more modern form of prospectus leaflet in a tasteful shade of orange, and a very satisfactory meeting with the Malacological Society, the first on record of its kind and which introduced an era of closer co-operation. Soon after that, our meetings ceased to be held in the Board Room of the Museum, which we were beginning to outgrow anyway, and members foregathered in the Conversazione Room where, in spite of poor acoustics, the accommodation was found to be more suitable.

Social meetings had been very few and far between, ours being an organization

which appears to be preoccupied continuously with the technical reasons for its existence, but in May 1968 Miss J. Sawyer arranged a luncheon at Kettner's for as many local members as wished to come. This was a success, and it may be of interest to record that it was attended by invitation by Juliet Railston-Brown, a hopelessly crippled child of nine whose intense interest in shells had drawn upon her the attention of the Society, individual members having done a good deal to make her few poor years pleasant for her. She and her mother both seemed greatly to treasure the privilege of attending.

The following year, on Mrs. McMillan's assumption of the editorial duties, printing was transferred to Willmer Bros. of Birkenhead, and satisfactory service is still being provided by this firm. The *Journal* was now produced in quarto format and on a more regular basis.

The Society began to be a little conscience-stricken about the fact that its meetings were always held in London, whereas a large proportion of its membership lived in the north, many of them travelling remarkably long distances to attend. It was therefore laid down as a principle that ordinary meetings should sometimes be held in the provinces, and a very successful gathering was organized at the Manchester Museum in April 1970, addressed appropriately enough by Jackson. Next year it was the turn of Leeds. The subscription was very reluctantly raised to £3 at this time, the Treasurer, Mrs. Fogan, regarding the event as a personal defeat.

The marine census situation was developing rapidly under the guidance of Mrs. Turk, and became a highly effective instrument through the liaison which was set up with the Monkswood Biological Records Centre, where all census information was put on computer. In 1971 it was learned that heavy hire charges for the Conversazione Room would be imposed by the Museum authorities, and a search began for alternative accommodation, which resulted in an agreement with the Linnean Society to use, for a fee, their small meeting room on the top storey at Burlington House. The first meeting there took place on 16 October, and the accommodation was found to have certain disadvantages; it seemed also a very few months before the Linnean Society revoked the agreement, withdrew permission for the use of the room, and offered instead the main meeting room on the ground floor at a considerably augmented fee. This was unacceptable, it proved possible to negotiate more favourable terms than previously with the British Museum (N.H.), and by November 1972 we were back in the old familiar quarters.

This year too, saw the publication of the Marine Concordance and the commencement of a linked series of area representatives for marine recording. Records were transferred to BRC 80-column cards for the computer, as had already been the case for the non-marine system. Archives were accepted for storage at the National Museum of Wales, and it is hoped that all our historical papers will be sent there this year. The Society is very fortunate in that a large proportion of these records, including all the minute books, have survived the vicissitudes of up to a century, for it would certainly have been impossible to write a history

such as this without them. What the records also reveal is a great deal of interest attaching to well known conchological characters of the past, and the interplay of personalities long ago has made fascinating reading; I should like to think that one day some of it may be written up for the amusement and edification of the present members. Much indeed remains that might be done.

As one of many who have the welfare of our Society very much at heart, it has given me a good deal of pleasure to note that the history I have attempted to relate (and I must make it clear that it is a very subjective one with no claim to official backing) seems to me to leave the Society in a very healthy state. Its amateur-professional status is well maintained, the enthusiasm of its members with all their wide variety of interests seems unbounded, and it is an origin of many deep and lasting friendships. It is fully carrying out what it set out to do nearly a hundred years ago and I feel that the four friends who began it all could not but approve if they were with us now. I look forward confidently to the future, even to the inevitability of more growing-pains, but with the hope that some member as yet unborn will be able to render to a gathering such as this a report of the second hundred years as satisfactory in so many ways as the one I have submitted to you today.

REFERENCE

Jackson, J. W., 1927. History of the Conchological Society. *J. Conch., Lond.* **18**: 65–69.

APPENDIX I

Yearly Record (after Castell)

Year	J.C. Vol.	A.G.M.	President	Membership	Events
1874	1				A Journal only.
1875					
1876			W. Nelson	4	Conchological Club formed October.
1877			W. Nelson		Conchological Society G. B. & I., November.
1878	2	11.77	W. Nelson		
1879		12.78	W. Nelson		
1880	3	12.79	J. W. Taylor		Office of Recorder created.
1881		12.80	J. W. Taylor	25	
1882		12.81	W. Cash	26	
1883	4	12.82	W. H. Evans		Taylor started his Monograph.
1884		12.83	G. H. Parke		
1885		1.85	W. Jeffery		Molluscan list published.
1886	5	12.85	W. D. Roebuck		
1887		12.86	J. W. Taylor	c. 156	Voting papers and ballots.
1888		12.87	S. Hanley		Manchester Branch. J. C. made official organ.
1889	6	12.88	J. C. Melville	180	Rules published.
1890		12.89	E. A. Smith	199	
1891		12.90	R. B. Watson	215	

1892	7	12.91	A. M. Norman	220	
1893		11.92	P. B. Mason	223	
1894		11.93	W. E. Hoyle	205	
1895	8	5.94	J. W. Taylor	213	Soc. moves to Manchester. Owns *J. Conch.*
1896		5.95	J. C. Melville	232	London Branch January.
1897		9.96	S. J. Hickson	243	
1898	9	11.97	J. R. B. Masefield	240	
1899		10.98	L. E. Adams	254	
1900		10.99	E. R. Sykes	263	
1901	10	10.00	A. Somerville	273	
1902		9.01	A. Somerville	276	
1903		10.02	R. F. Scharff	284	
1904	11	9.03	R. F. Scharff	289	
1905		10.04	G. W. Chaster	298	
1906		10.05	G. W. Chaster	319	
1907	12	10.06	W. E. Collinge	319	
1908		10.07	W. E. Collinge	337	
1909		10.08	H. H. Godwin-Austen	330	
1910	13	10.09	H. H. Godwin-Austen	338	
1911		10.10	J. W. Horsley	339	
1912		10.11	J. W. Horsley	340	
1913	14	10.12	H. H. Gwatkin	350	
1914		10.13	R. B. Newton	322	N. Staffordshire Branch.
1915		9.14	R. B. Newton	321	
1916	15	10.15	R. Standen	318	
1917		10.16	A. E. Boycott	309	
1918		10.17	A. E. Boycott	287	
1919	16	10.18	E. Collier	290	Sub. now 10s.
1920		10.19	A. H. Cooke	290	
1921		10.20	J. R. le B. Tomlin	277	1st N. M. Census (Roebuck Mem. No.) issued.
1922		10.21	E. W. Swanton	273	
1923	17	10.22	R. J. Welch	279	
1924		10.23	J. W. Jackson	274	Marine Recordership created.
1925		10.24	H. Crowther	272	
1926	18	10.25	J. W. Taylor	259	McClelland's Index.
1927		10.26	H. Watson	247	
1928		10.27	A. S. Kennard	237	
1929		10.28	H. H. Bloomer	241	Research Fund originated.
1930	19	10.29	M. Connolly	250	
1931		10.30	R. Winckworth	242	
1932		10.31	E. W. Bowell	238	Winckworth List issued.
1933		10.32	J. E. Cooper	223	
1934	20	10.33	A. P. Gardiner	222	
1935		10.34	J. D. Dean	213	
1936		10.35	A. J. Peile	210	Institutional membership instituted.
1937		10.36	A. J. Peile	217	
1938	21	10.37	C. Diver	207	
1939		10.38	C. Diver	205	
1940		11.39	A. E. Ellis	203	
1941		2.41	A. E. Ellis	199	
1942		11.41	H. E. Quick	199	
1943	22	2.43	H. E. Quick	197	
1944		10.43	A. E. Salisbury	199	
1945		2.45	A. E. Salisbury	202	
1946		12.45	A. T. Hopwood	174	London now H.Q. Sub. now £1.
1947		11.46	A. T. Hopwood	190	Library moved to Leeds.

1948	23	2.48	J. R. le B. Tomlin	150	
1949		12.48	J. R. le B. Tomlin	160	
1950		12.49	G. L. Wilkins	170	Syllabus issued.
1951		2.51	G. L. Wilkins	182	Census (Boycott Mem. No.) issued.
1952		2.52	A. G. Davis	171	
1953		2.53	A. G. Davis	182	
1954	24	2.54	L. W. Stratton	183	Library sold. Collections in B.M.N.H.
1955		2.55	L. W. Stratton	188	
1956		2.56	Mrs. N. F. McMillan	189	
1957		2.57	Mrs. N. F. McMillan	196	
1958		2.58	H. E. J. Biggs	183	
1959		2.59	H. E. J. Biggs	183	Prospectus issued, with rules.
1960		2.60	C. P. Castell	186	
1961	25	2.61	C. P. Castell	198	Newsletter issued. Agency ceased. 10 km grid adopted.
1962		2.62	L. W. Stratton	219	European Malac. Union. Soc. a charity. Field meeting organiser created.
1963		2.63	L. W. Stratton	251	
1964		2.64	M. P. Kerney	287	Junior membership and Student papers.
1965		2.65	M. P. Kerney	320	Sub. now £2.
1966	26	2.66	S. P. Dance	347	
1967		2.67	S. P. Dance	374	
1968		2.68	B. Verdcourt	401	Meetings in Conversazione Room.
1969	27	2.69	B. Verdcourt	432	
1970		2.70	T. Pain	465	Sub. now £3.
1971		2.71	T. Pain	493	Some meetings at Linnean Soc. rooms.
1972		2.72	T. E. Crowley	492	Marine concordance issued. Area reps.
1973	28	2.73	T. E. Crowley	501	
1974		2.74	June E. Chatfield	522	

APPENDIX 2: OFFICE BEARERS

Hon. Secretary
1876 W. D. Roebuck
1877 H. Crowther
1878 J. W. Taylor
1880 T. W. Bell
1890 W. D. Roebuck
1895 E. Collier
1896 W. E. Hoyle
1907 L. J. Shackleford
1917 J. W. Jackson
1923 R. Standen
1924 J. W. Jackson
1946 Mrs. N. F. McMillan
1951 C. P. Castell
1960 T. E. Crowley
1970 Miss J. Sawyer
1972 Mrs. E. B. Rands

Editor
1874 J. W. Taylor
1894 W. E. Hoyle
1907 J. R. le B. Tomlin
1948 A. E. Ellis
1965 D. Heppell
1969 Mrs. N. F. McMillan
1974 C. R. C. Paul

Hon. Treasurer
1876 W. D. Roebuck
1880 R. Scharff
1881 T. W. Bell
1889 W. D. Roebuck
1890 L. E. Adams
1898 E. D. Bostock
1918 C. Oldham
1940 A. E. Salisbury
1958 C. A. Raffray
1967 Mrs. M. Fogan

Nonmarine Recorder
1877 W. D. Roebuck
1886 J. W. Taylor

1887 W. D. Roebuck
1895 E. Collier
1897 T. Rogers
1900 L. E. Adams
1904 C. Oldham
1907 F. Taylor
1912 W. D. Roebuck
1919 A. E. Boycott
1938 A. R. Waterston
1948 A. E. Ellis
1961 M. P. Kerney

MARINE RECORDER
1923 R. Winckworth
1931 A. P. Gardiner
1952 Mrs. N. F. McMillan
1962 D. Heppell
1966 Mrs. S. M. Turk
1974 Mrs. S. Smith

CURATOR
1877 W. Nelson
1894 R. Standen
1925 E. R. Brown
1930 C. H. Moore
1946 Mrs. N. F. McMillan
1948 W. Thurgood
1950 Mrs. A. Thurgood
1953 A. G. Davis
1958 F. H. Cozens
1964 A. E. Ellis
1965 Miss J. Chatfield

LIBRARIAN
1889 W. E. Collinge
1891 E. R. Waite
1893 H. Crowther
1895 W. E. Hoyle
1901 F. F. Laidlaw
1906 J. W. Jackson
1921 A. T. Hopwood
Subsequently as for Curator until disposal of library in 1964.

NEWSLETTER COMPILER
1961 M. Goodchild
1964 P. E. Negus

FIELD MEETING ORGANISER
1962 T. Pain

HON. SECRETARY, LEEDS BRANCH
1895 H. Crowther
1897 Roebuck and Nelson
1900 Mrs. Crowther and Mrs. Brierley
1902 W. Cash
1903 Roebuck and Taylor
1904 F. Booth and Crowther
1905 F. Booth
1925 H. L. Stephenson
1926 J. R. Dibb
1936 E. Dearing
1941 W. Thurgood
1949 W. D. Fisher
1952 S. G. Appleyard
1956 E. Dearing

HON. SECRETARY, MANCHESTER BRANCH
1888–1895 R. Standen

HON. SECRETARY, LONDON BRANCH
1896 J. E. Cooper
1921 J. C. Dacie
1929–1946 G. L. Wilkins

HON. SECRETARY, N. STAFFORDSHIRE BRANCH
1913 B. Bryan

Note. Office holders were not always members of Council.

JUNIOR SECTION LEADER
1964 H. E. J. Biggs
1972 A. J. Rundle

APPENDIX 3: SPECIAL PUBLICATIONS

(a) British non-marine lists

Q. J. Conch. 1875 (Nelson & Taylor)

J. Conch. **4**: 45–54 (1883)

J. Conch. **7**: 49–66 (1892)

J. Conch. **10**: 352–367 (1903)

Kennard and Woodward's List, not published by the Society but in same format (1914)

J. Conch. **21**: 260–274 (1941)

(b) Non-marine census
J. Conch. **10**: 217–237 (1902)
J. Conch. **16**: 165–211 (1921)
J. Conch. **23**: nos. 6–7 complete (1951)
J. Conch. **25** Supplement (1966)

(c) Marine lists
J. Conch. **10**: 9–27, 280, 281 (1901/03)
J. Conch. **19**: 211–252 (1932): 'Winckworth'
J. Conch. **25**: 299–303 (1964): areas

APPENDIX 4: OBITUARIES PUBLISHED IN THE JOURNAL OF CONCHOLOGY

(* indicates that there is a portrait with the obituary.)

Abercrombie, A.	18 : 35 (1926)
Adams, L. E.	22 : 204 (1946)
Alkins, W. E.	27 : 432 (1972)
Ashford, C.	7 : 405 (1894)*
Bacchus, A. D. R.	17 : 161 (1924)
Babington, C.	6 : 59 (1889)
Baldwin, D. D.	14 : 97 (1913)
Baldwin, J. W.	13 : 352 (1912)
Barclay, D.	6 : 58 (1889)
Barnard, K. H.	25 : 359 (1965)*
Bartsch, P.	25 : 40 (1961)*
Becker, H. F.	15 : 221 (1917)
Beeston, H.	25 : 132 (1962)*
Bensley, J. F.	24 : 213 (1957)
Bergh, R.	22 : 225 (1946)
Biggs, H. E. J.	28 : 131 (1973)*
Blackburn, E. P.	27 : 353 (1972)*
Blair, D. P.	26 : 421 (1971)
Bloomer, H. H.	24 : 448 (1960)*
Boettger, O.	23 : 162 (1911)
Bowell, A. W.	20 : 101 (1935)
Boycott, A. E.	21 : 58 (1938)
Brasier, J.	19 : 110 (1931)
Brown, T.	22 : 132 (1945)
Bullen, R. A.	14 : 13 (1913)
Burkill, C.	6 : 382 (1891)
Byne, L. St G.	22 : 272 (1947)
Cairns, R.	13 : 290 (1912)*
Cash, W.	14 : 328 (1915)*
Castell, C. P.	27 : 520 (1972)*
Chaster, G. W.	13 : 72 (1910)
Coates, H.	20 : 262 (1936)
Cockerell, T. D. A.	23 : 19 (1948)
Cocks, W. P.	27 : 253 (1971)
Collinge, W. E.	P. Malac. Soc. only, 1949
Collier, E.	16 : 136 (1921)
Connolly, M.	22 : 289 (1947)
Cooke, A. H.	20 : 77 (1934)
Cooper, J. E.	23 : 359 (1953)
da Costa, S. I.	12 : 139 (1908)
Crick, W. D.	11 : 116 (1904)
Crosse, J. C. H.	9 : 212 (1899)*
Crowther, H.	21 : 69 (1938)
Dacie, J. C.	18 : 330 (1929)
Dalgliesh, J. G.	21 : 275 (1941)
Darbishire, R. D.	12 : 258 (1909)*
Darrah, A. L.	23 : 163 (1951)
Davis, A. G.	24 : 214 (1957)
Dean, J. D.	20 : 338 (1937)
Deshayes, G. P.	1 : 88 (1875)
Diver, C.	21 : 69 (1938)*
Eliot, C. N. E.	19 : 145 (1931)
Elston, P.	27 : 130 (1970)
Fischer, D. M. H.	15 : 123 (1915)
Fisher, W. D.	23 : 164 (1951)
Fowler, T. G. W.	26 : 333 (1968)*
Fulton, H. C.	22 : 2 (1943)
Gabriel, C. J.	26 : 75 (1966)*
Gardiner, A. P.	23 : 285 (1952)
Garrett, A.	5 : 317 (1888)
Glover, T.	5 : 231 (1887)
Grensted, L. W.	25 : 291 (1964)*
Godwin-Austen, H. H.	17 : 141 (1924)
Guppy, R. J. L.	15 : 189 (1917)
Haas, F.	27 : 182 (1970)
Hanley, S. T.	9 : 269 (1900)
Hargreaves, J. A.	18 : 325 (1929)
Hawkins, H. L.	26 : 418 (1971)
Hawell, J.	11 : 164 (1905)
Hedley, C.	18 : 148 (1927)
Heginbothom, C. D.	23 : 162 (1951)
Horsley, J. W.	16 : 247 (1922)
Hoyle, W. E.	18 : 33 (1926)
Iehring, H. von	19 : 52 (1930)
Jeffreys, J. G.	4 : 283 (1885)
Jordan, H. K.	22 : 95 (1943)
Jukes-Brown, A. J.	14 : 281 (1915)
Kennard, A. S.	23 : 20 (1948)
Kennelly, D. H.	27 : 433 (1972)
Kevan, D. K.	26 : 419 (1971)
Kisch, B. S.	25 : 83 (1962)*
Laidlaw, F. F.	25 : 288 (1964)*
Laver, H.	15 : 286 (1919)
Layard, E. L.	9 : 328 (1900)
Lloyd, R. M.	4 : 88 (1875)
Loydell, A.	13 : 64 (1910)
Lucas, B. R.	21 : 322 (1942)
Lumb, J. H.	26 : 201 (1967)*
Madison, J.	14 : 291 (1915)
Marquand, E. D.	15 : 257 (1919)
Marratt, F. P.	11 : 275 (1905)
Marshall, J. T.	17 : 99 (1924)
Martens, E. von	11 : 171 (1905)*
Mason, P. B.	11 : 104 (1904)
Masefield, J. R. B.	19 : 253 (1932)*
McClelland, H.	22 : 49 (1943)
Melvill, J. C.	19 : 41 (1930)
Metcalfe, W.	22 : 95 (1943)
Monterosato, de	19 : 37 & 111 (1930/31)
Moore, C. H.	23 : 85 (1949)
Morehouse, Elsie M.	27 : 2 (1969)
Moses, R. H.	23 : 89 (1949)
Moss, W.	14 : 169 (1914)
Nelson, W.	11 : 357 (1906)
Newton, R. B.	18 : 11 (1926)
Nordgaard, R. B.	19 : 170 (1931)
Norman, A. M.	16 : 40 (1919)
Oldham, C.	22 : 1 (1943)*

Orr, H. L.	14 : 97 (1913)	Standen, R.	17 : 225 (1925)
Overton, H.	23 : 299 (1953)	Steenburg, C. M.	22 : 117 (1946)
Peile, A. J.	23 : 21 (1948)	Stelfox, A. W.	27 : 520 (1972)*
Phillips, R. A.	22 : 205 (1946)	Stratton, L. W.	27 : 427 (1972)*
Polinski, W.	19 : 108 (1931)	Stubbs, A. G.	23 : 120 (1950)
Ponsonby-Fane, J. H.	15 : 195 (1917)	Swanton, E. W.	24 : 326 (1959)
Quick, H. E.	26 : 275 (1968)*	Taylor, F.	23 : 86 (1949)
Reeve, L.	9 : 344 (1900)*	Taylor, G. W.	14 : 98 (1913)
Rendall, R.	26 : 273 (1968)*	Taylor, J. W.	19 : 157 (1931)*
Renton, R.	14 : 296 (1915)	Thompson, I. C.	11 : 14 (1904)
Richards, C. P.	21 : 322 (1942)	Thurgood, W.	23 : 119 (1950)
Robertson, D.	8 : 329 (1897)	Tomlin, J. R. le B.	24 : 29 (1955)
Robertson, Jessie D.	22 : 95 (1943)	Turner, R.	26 : 334 (1968)
Roebuck, W. D.	16 : 37 (1919)	Turner, W.	9 : 16 (1898)
Rogers, T.	10 : 142 (1902)	Venmans, L. A. W. C.	24 : 449 (1960)
Salisbury, A. E.	25 : 293 (1964)	Wakefield, H. R.	23 : 62 (1949)
Scharff, R. F.	20 : 79 (1934)	Warren, Miss A. E. M.	21 : 57 (1938)
Schilder, F. A.	27 : 429 (1972)*	Watson, H.	24 : 359 & 407 (1959)*
Schlesch, H.	25 : 202 (1963)*	Watson, R. B.	13 : 139 (1911)*
Shackleford, L. J.	25 : 193 (1917)	Welch, R. J.	20 : 329 (1937)
Sinel, J.	18 : 330 (1929)	Wilkins, G. L.	24 : 216 (1957)
Smith, A. E.	15 : 150 (1916)	Williams, J. M.	18 : 9 (1926)
Somerville, A.	12 : 116 (1908)	Winckworth, H. C.	23 : 21 (1948)
Sowden, H.	20 : 291 (1937)	Winckworth, R.	23 : 157 (1951)
Sowerby, G. B. III	16 : 213 (1921)	Woodward, B. B.	19 : 145 (1931)
Stainton, E.	23 : 89 (1949)	Wright, C. E.	18 : 37 (1926)

APPENDIX 5: THE ARCHIVES

The Society's records consist mainly of the following:

A. Bound set of the *Journal of Conchology*.
B. Set of the *Conchologists' Newsletter*.
C. Minute books of the Ordinary and Council meetings as follows:
   1. 2/10/1876 to 15/12/1881
   2. 2/2/1882 to 15/12/1887
   3. 5/1/1888 to 4/11/1891
   4. Manchester Branch, 11/2/1888 to 14/3/1895
   5. 12/12/1891 to 6/9/1893
   6. 16/9/1893 to 18/5/1895
   7. 3/7/1895 to 12/12/1900
   8. 9/1/1901 to 11/12/1911
   9. 8/3/1911 to 7/9/1921
   10. 15/10/1921 to 16/9/1933
   11. 14/10/1929 to 22/5/1939
   12. 14/4/1936 to 18/11/1950
   13. 1951 to 1972
   14. 1973 onwards.

A separate set of council minute books has been kept from 1929 to date.

D. Book of membership listings 1882–1890 with dates, addresses and dues.
E. Castell's listing of all members 1877 to 1947 and supplement; with addresses, joining and parting dates, journal mentions etc.
F. Attendance register for ordinary meetings, 1911 to 1961 and 1962 to date.
G. Holograph collection of notable conchologists.
H. Photograph collection of officers, members and other conchologists.
I. Trustee papers.
J. Programme sheets and syllabus cards, 1949 to date.

K. Miscellaneous printed papers issued by the Society; early voting papers, election notifications, bills, appeals, proposal forms, jubilee announcement etc.
L. Early letterheads of other societies and of firms which did business with the Society; odd curious papers amassed by the officers through the years.
M. Correspondence files; general correspondence in date order by the year, special subjects separately under title.
N. Papers connected with McClelland's Index, Kennard's Molluscan List, etc.
O. Papers of Roebuck's; part of his cutting collection, working notes and preliminary records in connection with the Census.
P. Taylor's *Monograph*; announcements and correspondence; working papers on many projects through the years, anatomical and other sketches and drawings, lecture notes etc.

Note. Most of the surviving manuscript of Taylor's *Monograph*, together with original coloured drawings, are in Leeds Museum under the care of the Yorkshire Society; also the minute books of the Yorkshire Branch.

J. Conch. 28: 295–300 (1975)

AN INVESTIGATION INTO THE EFFECT OF RUNNING WATER ON SHELL DIMENSIONS IN *ANCYLUS FLUVIATILIS* MÜLLER

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(*Read before the Society, 18 May 1974*)

INTRODUCTION

Ancylus fluviatilis Müller, although called the river limpet, is found not only in fast flowing rivers and streams but also on the shores of lakes where the stones are relatively free from detritus (Macan 1950, Hunter 1953).

In torrential fauna of fast flowing rivers the main determining habitat factor is water speed and flow (Dowdeswell 1959). As *A. fluviatilis* is found in both lentic (slow, living in pond or lake) and lotic (flowed over, living in river or brook) water, it provides a comparison between the two habitats.

The marine limpet, *Patella vulgata* (Lamarck), provides a similar comparative study although it is much larger than *A. fluviatilis* and lives under different conditions of flow. If the width/height ratio of the shell is measured for limpets of exposed and sheltered rocky shores, notable differences occur. Those of exposed shores have high narrow-based shells, whilst on sheltered shores the height is lower and the base broader (Moore 1934). Orton (1932, pp. 7, 10) suggested that limpets of exposed shores have frequently to pull down the shell on to the rock to resist wave action or desiccation and that this continual downward pull by muscles (situated some distance from the shell margin) might affect the shell form by pulling in the mantle margin which secretes the shell at the growing edge. Limpets not exposed to desiccation or turbulence have no such restraint on the lateral extension of the mantle edge. When specimens from exposed rock, with conical shells, are transferred to pools, the pronounced ledge which forms around the shell illustrates the subsequent affect on growth. It was these results which prompted this investigation.

AREA OF STUDY

The sites chosen for the investigation were the Brathay River, which enters Lake Windermere near Galava Fort, and the north-western shore of the lake itself. The surveys were carried out in March, April and September 1973.

The speed of the river was measured with an Ott Meter Flow Gauge at each sample point. The river speed varied considerably, especially between the surface of the water and the river bed. The speed was measured close to the surface of

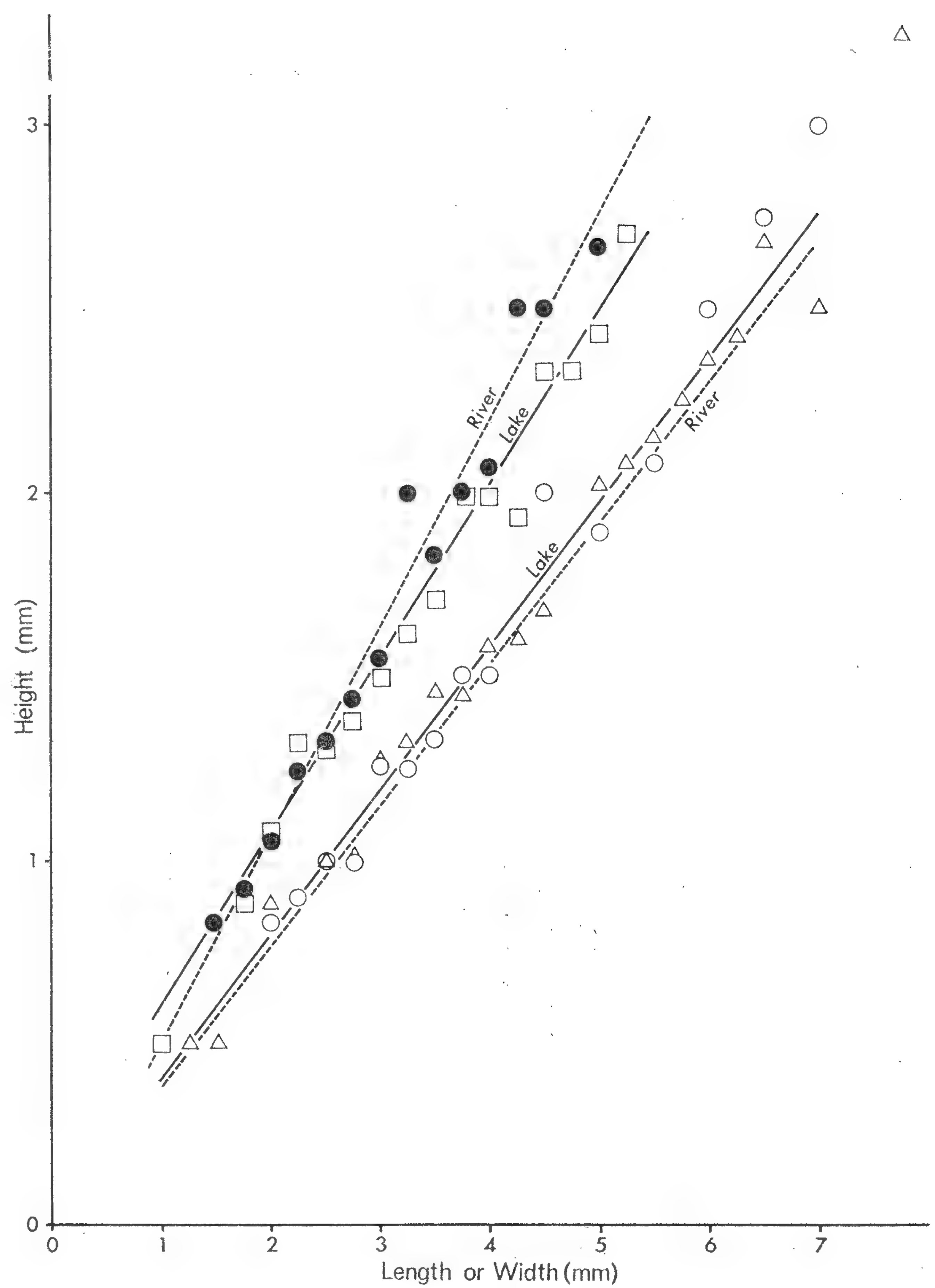

Fig. 1. A comparison of height against length and height against width of river and lake samples of *Ancylus fluviatilis*. L. Windermere length △, width □, R. Brathay length ○, width ●.

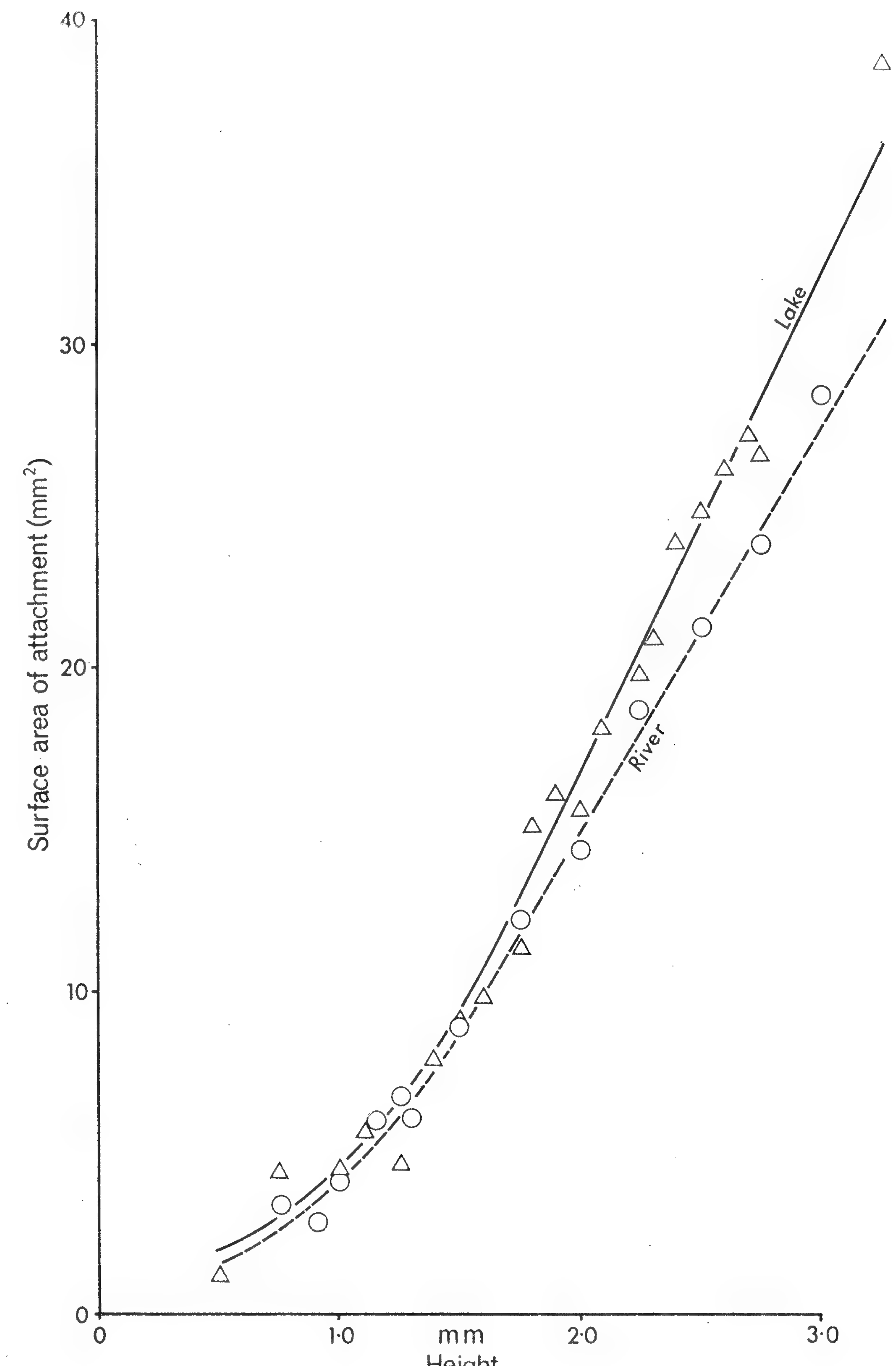

Fig. 2. A comparison of surface area of attachment against height of river and lake samples of *Ancylus fluviatilis*. L. Windermere △, R. Brathay ○

the rocks and boulders where the limpets were attached. (The surface speed was not recorded, as this would have little effect on limpet growth and attachment on rocks). The average river flow was 10·0 cm/second, but limpets were collected at water speeds between 6·0 and 60·0 cm/second. Although there was some wave action on the lake shore, this was not measurable with the Ott Meter.

Besides water speed, oxygen tension, pH and temperature were also measured. The pH was the same, although the temperature was lower and the oxygen tension higher in the river. Substrata are similar. Both habitats consist of large stones and boulders, although those of Windermere were covered with more silt than those of the river and differences in limpet distribution occur. Limpets in the river were located mainly on the top, sides and leeward edge of boulders, seldom on the leading edge facing the current. In Lake Windermere limpets were found only on the leading edges of the rocks facing the waves.

METHODS OF SAMPLING

Areas of lake shore and river bed were examined closely and any limpets found were removed from the stones and measured to 0·1mm accuracy for length, width, and height, using sliding calipers. The limpets tended to be localised and were more common on stones with a surface area of 30·0 sq. cm. and over. The fringe of the limpet shell is flexible, which allows it to fit closely on the rock surface at many different resting places (Hunter 1953). Measurement of dimensions is, therefore, difficult and extreme care is needed.

TABLE 1. DIMENSIONS OF *ANCYLUS FLUVIATILIS*

DIMENSION		SAMPLE	
		R. BRATHAY N = 70	L. WINDERMERE N = 140
HEIGHT (H)	$\overline{H}$	1·55	1·61
	s_H	0·71	0·48
	Range	0·75–3·00	0·50–3·25
LENGTH (L)	$\overline{L}$	3·88	4·00
	s_L	0·90	1·21
	Range	2·00–7·00	1·25–7·75
WIDTH (W)	$\overline{W}$	2·91	3·19
	s_W	0·65	0·98
	Range	1·50–5·00	1·00–6·25
ATTACHMENT AREA (A)	$\overline{A}$	9·81	11·38
	s_A	4·06	6·70
	Range	2·00–29·00	3·00–39·00

Attachment area calculated as $A = \pi \left(\frac{W+L}{4}\right)^2$ N = number in sample, $\overline{H}$ = mean height, s_H = standard deviation of height, etc. Dimensions in mm except for Area which is in mm².

TABLE 2. RATIOS

SITE	RATIO WIDTH/HEIGHT (P) $\bar{P}$	s_P	AREA/HEIGHT (Q) $\bar{Q}$	s_Q	LENGTH/HEIGHT (R) $\bar{R}$
R. BRATHAY	1·88	0·26	6·35	1·34	2·47
L. WINDERMERE	1·99	0·27	6·89	1·86	2·51

RESULTS

The results of the survey are presented in Tables 1–3 and Figs. 1 and 2. The graphs (Figs. 1 and 2) were drawn by taking the mean values at particular lengths, widths and heights and drawing a 'best-fit' line through these points, using an amalgam of a double log graph plot, regression analysis and scatter diagrams. The range of results and the number of recordings at each value were also taken into account.

DISCUSSION

Tables 1 and 2 show that limpets from the River Brathay are consistently smaller than those from Lake Windermere. Geldiay (1956) found that the relationship between maximum sizes of *A. fluviatilis* in river and lake populations changed throughout the year. Sometimes the river forms were larger, at other times smaller. Although the present differences in size are slight, those in width and surface area indicate some statistical significance (Table 3).

TABLE 3. COMPARISON OF MEANS

MEAN	't' VALUE	PROBABILITY
$\bar{H}$	0·6	0·5
$\bar{W}$	2·15	0·05–0·02
$\bar{L}$	0·8	0·5
$\bar{A}$	2·12	0·05–0·02
$\bar{P}$	3·55	0·001
$\bar{Q}$	2·41	0·02–0·01

Symbols as in Tables 1 and 2. In this table the Probability is the likelihood of obtaining two samples with the observed difference in mean values from the same population.

Significant differences cannot be detected between river and lake limpets with respect to length/height ratio (Table 2). There is also no evidence from Fig. 1 of a height peak or a flattening of the graph lines which might have been expected if taller river limpets were affected by water flow. The limited data available suggest that the R. Brathay length/height graph may well turn toward, or slope through the points drawn after 6·0 mm in length but there is insufficient evidence, at the moment, to be sure of this. The same may also apply to Windermere limpets.

River Brathay limpets are higher for particular widths than their Lake Windermere counterparts (Fig. 1). It seems from this that *A. fluviatilis* displays a similar structural, and consequential behavioural, adaptation to *Patella vulgata.* When the width/height ratio for the two samples (Table 2) is compared by a 't' test, a highly significant result is obtained (Table 3). Since river limpets are not normally exposed to desiccation it is presumably the turbulence which affects their growth.

Durrant (1968 unpublished) surveyed *A. fluviatilis* in the River Gara, Devon. The width/height ratio for a sample of 50 was 1·76 (± 0·32). The difference between the means of the sample from this river and that from Windermere is highly significant. Even within the same river system variations in the width/height ratio occur. At a fast part of the river (50 cm/sec.) the width/height ratio was 1·40 (± 0·36), whereas a quiet backwater stretch had a ratio of 1·90 (± 0·18). In this respect *A. fluviatilis* may pose a problem in investigation, as the shell height/width ratio may vary with prevalent river conditions (Geldiay 1956). There are indications of such variations from the River Brathay sample when there are localised differences in current speed. For instance, at 45 cm/sec. the width/height ratio was 1·62, at 10 cm/sec. river speed it was 1·76. Shell sections indicate ridging, which may represent uneven growth rates in respect to shell shape.

River limpets have a smaller surface area of attachment (Fig. 2 and Table 2) than lake limpets. A student 't' test shows the difference between the means to be highly significant (Table 3). If surface area of attachment were directly related to water speed, one would expect river limpets to have the larger attachment area. If, however, river limpets behave in the same way that Orton (1932) suggested for *Patella vulgata,* i.e. if there is a constant downpull of peripheral foot musculature to compensate for river flow resulting in the more cone-like shell with a narrower base, this would account for the smaller attachment area of the river sample in comparison with the lake specimens.

SUMMARY

1. There is little difference between the overall size of the river and lake samples of *A. fluviatilis* when height and length are compared, but differences in width and surface area occur.
2. There is no indication of a direct relationship between height attained by limpets and water speed.
3. River limpets have greater width/height ratios than their lake counterparts. This is the opposite of what might be expected as higher shells create more resistance to water flow. The results for *A. fluviatilis* do, however, correspond with those for marine limpets (Orton 1932, Moore 1934). Orton's (1932) explanation may, therefore, be valid for *A. fluviatilis* as well as for *Patella vulgata.* It must be supposed that the size and shape of all *A. fluviatilis* are well within any limits set by water speed and current. Quite possibly this is because *A. fluviatilis* remains small enough throughout its growth to be within

the boundary layer, where friction with the river bed reduces water velocity and consequently drag. This, in itself, would be an adaptation of considerable advantage in a river habitat with its constantly changing water flow. River limpets, it seems, are 'little worried' about drag reduction or streamlining!

ACKNOWLEDGMENTS

I would like to thank Mr. Mike Mortimer of the Brathay Field Study Centre and Mrs. E. Smith who helped in the arduous task of collection and to my wife for her assistance in the typing of this paper. I would also like to thank Mr. R. Chandler of the Hatfield Polytechnic for verifying the use of a 't' test with a width/height ratio.

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THE ECOLOGY OF MOLLUSCA IN ANCIENT WOODLAND. I THE FAUNA OF HAYLEY WOOD, CAMBRIDGESHIRE.

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(*Read before the Society, 19 October 1974*)

INTRODUCTION

During the late Boreal and Atlantic periods of the post-glacial (zones VI and VIIa, *c.* 7,000–3,000 BC) climax oak forest developed over virtually all of southern Britain and a woodland mollusc fauna must have been equally widespread. Man has since enriched the mollusc fauna both by diversifying the environment (i.e. by clearing the forest) and by introducing new species. Recognition of the 'native' mollusc fauna of Britain relies almost entirely on fossil evidence (Kerney, 1966, 1968). However, patches of ancient woodland, which have probably never been cleared and put to other agricultural purposes, survive in Britain and may contain surviving relics of the original forest fauna and flora. This and two following papers record an attempt to detect any surviving relics of the Atlantic woodland mollusc fauna in some ancient woods of west Cambridgeshire and adjacent parts of Huntingdonshire and Bedfordshire, as well as presenting a more detailed account of the ecology of molluscs in one such wood, Hayley Wood. Evidence for the antiquity of these woods has been presented by Rackham (1967) whose opinions have been accepted throughout.

The study has taken three separate aspects. Firstly Hayley Wood was visited five times in spring 1966 and then regularly throughout the year September 1970 to September 1971. Records were kept of the species seen, their distribution, relative abundance and state of maturity. Secondly a number of simple experiments were carried out to investigate the effects of coppicing and rates of migration of molluscs in Hayley Wood. Thirdly, with this more detailed background from one ancient wood, a few visits were made to nine other ancient woods and two patches of modern woodland to see which species were most commonly found in woodland. These three aspects will be presented in three separate papers.

PART 1 HAYLEY WOOD

Hayley Wood is situated south of the B1046 road between the villages of Longstowe and Little Gransden, Cambridgeshire, at an elevation of 250 ft. (76 m). It covers approximately 120 acres (45 hectares) and is divided by the main rides into four compass sections and the 'triangle' (Fig. 1). The east section is bordered

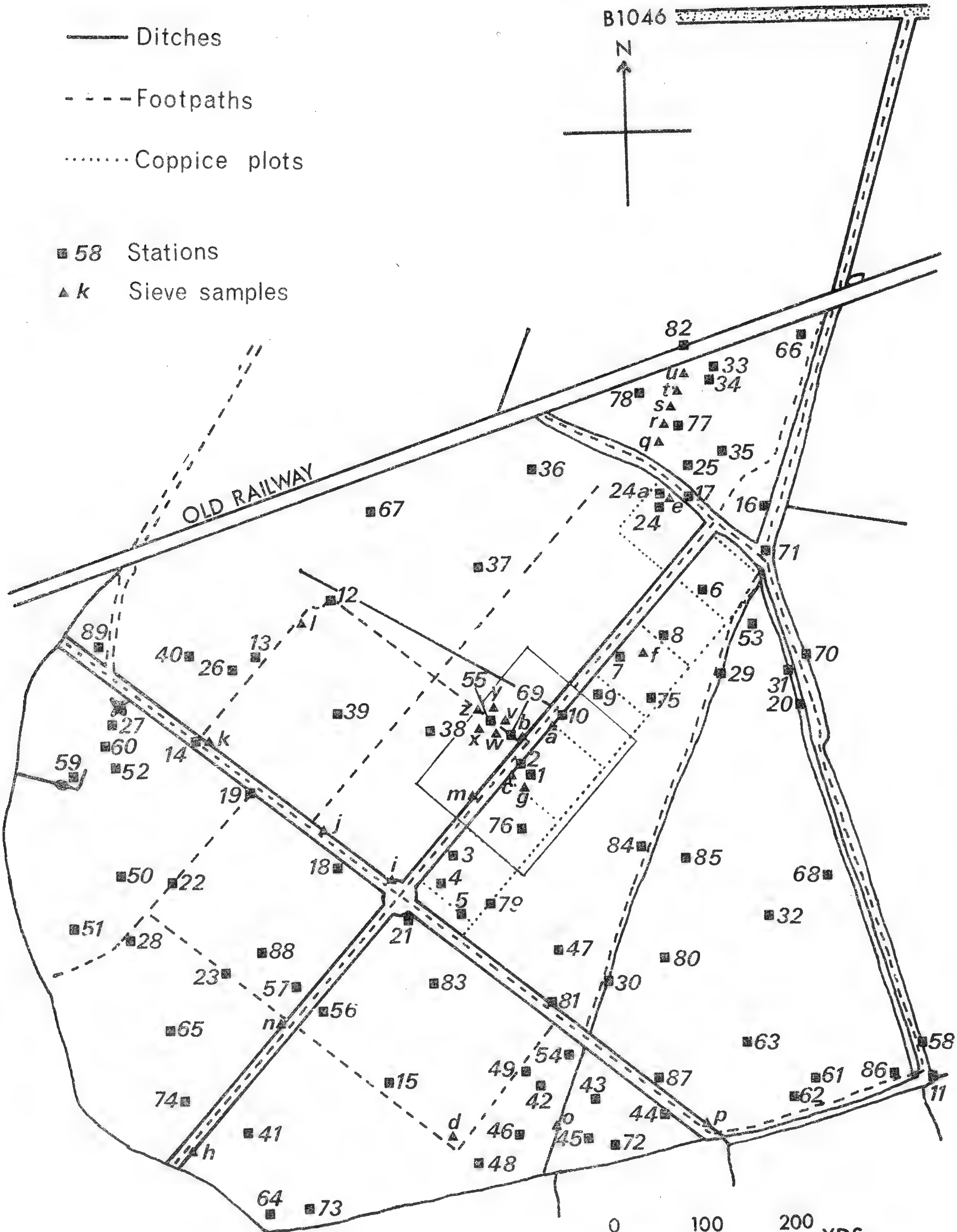


Fig. 1. Outline map of Hayley Wood to show collecting sites. Small area outlined in N and E sections shown in Fig. 2.

by Hayley Lane on the east and south sides while the triangle and the north section are bounded to the northwest by an abandoned railway which was working until at least 1966. Otherwise the wood is bordered by ditches and open fields. An intermittent stream flows through the south section in wet weather and is the source for a permanent brook which flows through Gamlingay and Potton to the River Ivel. An artificial horse-pond has been cleaned and re-established in the west section. Elsewhere, particularly beside Hayley Lane, small temporary pools occur. All the ditches lack standing water in summer but some remain damp and support aquatic molluscs and hygrophilous plants. The heavy boulder clay soil is low in phosphate (Rackham, 1967) and easily puddled and waterlogged in wet weather. Standing water is common in winter over the highest parts of the wood. In the main body of the wood the soil is undisturbed except for puddling, but the triangle shows distinct 'ridge and furrow' plough patterns indicating a prolonged period of agriculture in mediaeval times. The triangle is not therefore ancient woodland as here defined (i.e. woodland that has not been cleared and put to other agricultural purposes). Indeed an aerial photograph taken in 1922 shows it as a wheatfield (Rackham, personal communication 1971).

Despite being ancient woodland, the main body of Hayley Wood is far from being in a natural state. It is a deciduous wood which has been managed by 'coppice with standards' and still retains the three-storeyed structure as follows:

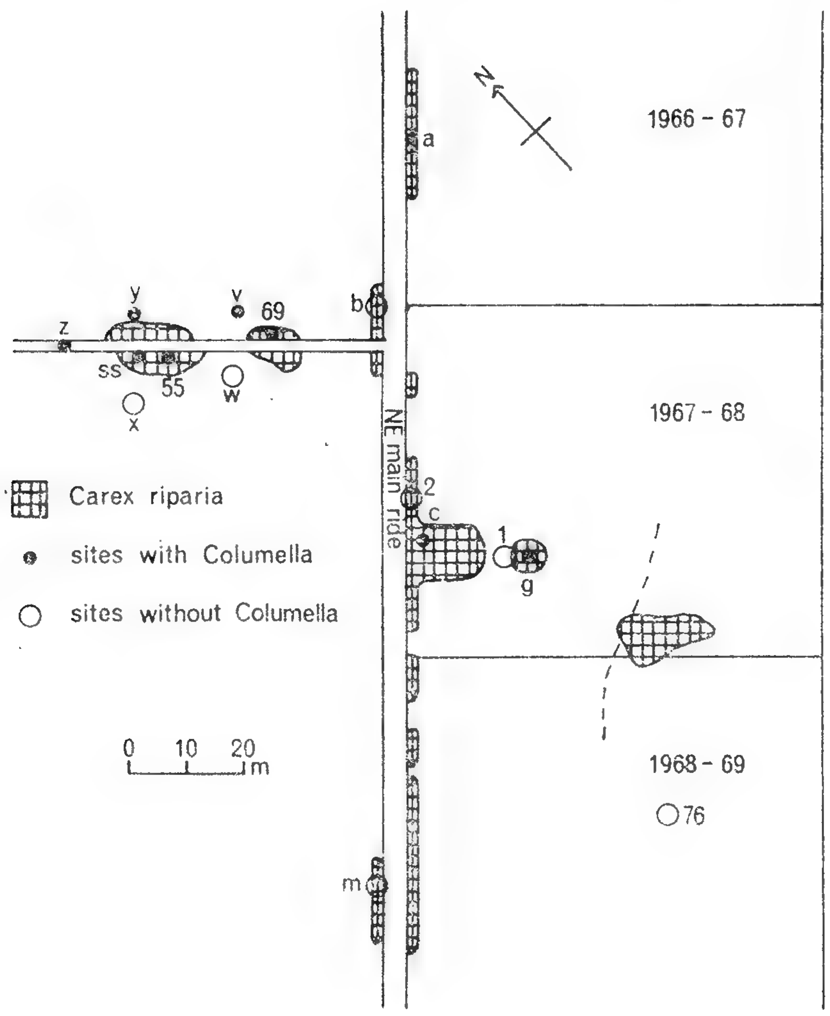
1. Large (standard) trees, mostly oak (*Quercus robur* L.) but with many ash (*Fraxinus excelsior* L.) as well.
2. Large coppice, mostly ash but some maple (*Acer campestre* L.)
3. Small coppice of hazel (*Corylus avellana L.*), hawthorn (*Crataegus oxyacanthoides* Thuillier) and more rarely blackthorn (*Prunus spinosa* L.).

Elm (*Ulmus carpinifolia* Gleditch) occurs in two groves both representing separate seedings which have spread by suckering. Elm was probably not cut regularly when coppicing was widely practiced before the First World War.

Ground vegetation includes *Carex riparia* Curtis, *Primula elatior* (L.), *Filipendula ulmaria* (L.), *Endymion nonscriptus* (L.), and *Mercurialis perennis* L. which can be used to zone the wood (Fig. 3). Other conspicuous herbs include *Carex sylvatica* Hudson, *Sanicula europea* L., *Circaea lutetiana* L., *Rubus caesius* L., *Geum urbanum* L., *Geranium robertianum* L., *Viola riviniana* Reichenbach and *V. reichenbachiana* Jordan. *Hedera helix* L., and *Urtica dioica* L. are surprisingly rare, the latter probably because of the low phosphate content of the soil.

The triangle lacks the three-storeyed structure since it was never coppiced and the trees are much closer together than the standard trees of the main wood. The ground vegetation is sparser and herbs characteristic of the main wood have spread only about 50 m into the triangle in the last 50 years or so.

At present the wood is not typical of its former state since coppicing has not been practiced widely for at least 50 years. It has recently been re-introduced on an experimental basis and an acre a year has been cut on a planned 14 year rotation. The main rides have also been widened in places and two small glades



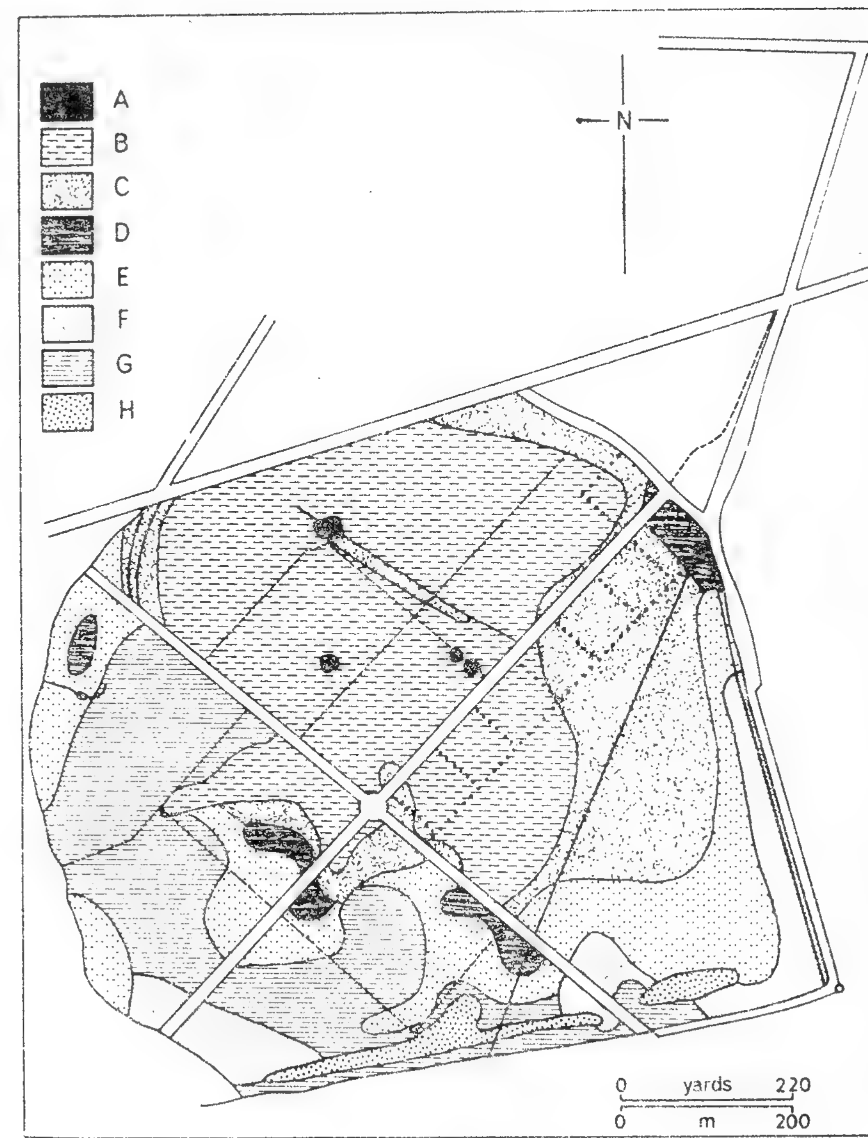


Fig. 2. (left) Details of collecting sites and the occurrence of *Carex riparia* in the N and E sections of Hayley Wood (4 June 1971). Note the association of *Columella edentula* with patches of *Carex riparia.* ss = unlettered sieve sample taken 2 May 1971, other letters refer to sieve samples, numbers to collecting stations (see Fig. 1).

Fig. 3. Map of ground vegetation zones in Hayley Wood (9 May 1966). A *Carex riparia;* B *Primula-Filipendula*; C *Primula-Endymion;* D *Endymion;* E *Endymion-Mercurialis;* F *Mercurialis* with occasional *Endymion;* G *Mercurialis;* H ash swamp zone. The Triangle is not included in the ground vegetation zones.

have been cleared. All these clearings have increased the growth of light loving herbs dramatically.

MOLLUSCAN HABITATS

From a molluscan standpoint Hayley Wood is a large ecological unit which is almost as clearly differentiated from the surrounding ploughed fields and grassland as an island is from the surrounding water. The main difference between the four compass sections involves the predominant ground vegetation zones present, although most molluscs appear to be less common in the north section. *Retinella pura* (Alder) and *Vitrina pellucida* (Müller) are distinctly more common in the south and west sections. The triangle is also different since it is recent woodland and lacks the characteristic ground vegetation of the main wood over most of its area.

Surface moisture and available cover are probably the two most important factors controlling mollusc distribution, although availability of suitable food and soil pH may also be important. Surface moisture is related to the ground vegetation zones but the relationship changes seasonally. The presence of sheltering sites above ground facilitates collection but their absence need not affect the molluscs

if suitable underground shelter is available, as seems to be the case over most of Hayley Wood.

Major molluscan habitats in the main wood may be defined in terms of surface moisture as follows:— (A) wet sites (ponds, pools, ditches, etc.) (B) Woodland sites (subdivided by vegetation zones) (C) Open sites (coppice plots, glades, etc) (D) marginal sites (hedgerows and margins of the wood) (E) special sites (fire sites, log piles, etc.). The triangle is also considered as a separate unit.

A. *Wet sites.* The only permanent body of water within the wood is the pond in the west section. In 1966, when recently cleaned out, it had clear water, some immigrant water weed and looked a promising site for colonization although no molluscs had yet reached it. By autumn 1970 the pond was muddy, fouled by birds and with a reduced weed. Again no molluscs were found and it is unlikely that any will now colonize it. *Pisidium personatum* Malm occurs in an adjacent ditch only 5 m away and presumably has had ample time to spread into the pond if it were a suitable habitat.

Ditches in the wood vary from shallow leaf-filled depressions which become waterlogged in winter to deep trenches which remain damp even in summer. The latter are sometimes choked with sedge and may contain 'aquatic' molluscs such as *Lymnaea truncatula* (Müller) and *P. personatum.* Both species were taken alive in September 1970 in a ditch which was barely damp (Station 21, Fig. 1). In June 1966 *P. personatum* and *P. obtusale* (Lamarck) were collected alive in muddy ground in the north section. The area was sufficiently dry at the time for small mammals to burrow beneath it! Although normally regarded as freshwater molluscs, in Hayley Wood they are little more aquatic than hygrophilous land snails such as *Carychium minimum* Müller and *Vitrea crystallina* (Müller).

I have applied the term 'pools' to enlargements of ditches and isolated pits which fill with water in winter and are found particularly commonly beside Hayley Lane in the east section and the triangle but occur sporadically elsewhere. In 1966 fresh shells of *Planorbis leucostoma* Millet were collected in one such pool (station 20, Fig. 1). In 1970 dead bleached shells could still be found but no live individuals were seen. *P. leucostoma* is a freshwater species found in temporary pools and has the ability to appear (often in large numbers) and disappear suddenly.

The *Carex riparia* zone was confined to four pool-like areas in the north section when the vegetation map was made in 1966. Only two of these survived in 1970–71 but the sedge had spread considerably into the adjacent coppice plots (Fig. 2). *Columella edentula* (Draparnaud) is associated with dense patches of this sedge which dry out less in summer than vegetation-free pools. Finally the ash swamp zone in the east and south sections constitutes another wet site for at least part of the year. Although the intermittent stream flows through it, like pools and ditches, open areas within the swamp become dry in summer. *C. edentula* is again found here but associated with clumps of *Carex sylvatica* and ash leaf litter.

B. *Woodland sites.* In the main body of the wood ground vegetation zones correlate fairly well with surface moisture but the relationship reverses seasonally. In spring (1966, 1971) zone B (*Primula-Filipendula*) was wettest and zone H (*Mercurialis*) driest, although all zones were damp by both mollusc and human standards. In summer and autumn the situation was reversed at least partly because *Mercurialis* forms a good cover almost all year round while *Primula elatior* and *Endymion nonscriptus* die down in summer. After a dry summer (1970) the driest parts of the wood were pools, open ditches and areas in zone B. Even zone H was dry with the *Mercurialis* wilting. During such dry spells molluscs shelter underground and are difficult to find. For example *Cochlicopa lubrica* (Müller) was only found as an accessory species (see below) before 19–11–70 and *Acanthinula aculeata* (Müller) was known from a single adult before 7–1–71. After these dates these and other species appeared much more commonly as the wood became very wet.

C. *Open sites.* The wood is modified by recent man-made clearings which include the coppice plots, glades and wider main rides. These areas lack the canopy of the wood and rampant ground vegetation develops within two or three years of clearing. The immediate effects of clearing are undesirable (but not necessarily harmful) to molluscs since they include a reduction in ground cover and an increase in light and wind, all of which tend to lower surface humidity. In spring (1966, 1971) the most recent coppice plots were the driest parts of the wood. Molluscs were hard to find and were presumably sheltering underground since slugs were particularly common under logs (which provide abundant surface shelter) in the south section glade in 1966. The lack of canopy allows heavy dew to form, particularly in summer and autumn, and this compensates for the loss of cover to some extent. In autumn 1970 the dampest parts of the wood were coppice plots with ground vegetation 15–30 cm high, the herbage presumably helping to retain moisture from heavy dews. Areas under the canopy of the wood were effectively without dew. Equally they are less affected by frosts than open sites.

The longer term effects of coppicing on molluscs are more difficult to assess but the rampant ground vegetation which develops may provide additional niches for some molluscs such as *Helix nemoralis* L. and *Agriolimax reticulatus* (Müller). Equally regular coppicing would prevent the occurrence of decaying fallen logs which are particularly favoured by *Discus rotundatus* (Férussac), *Marpessa laminata* (Montagu) and *Lehmannia marginata* (Müller). Coppicing, as practiced now, provides two special sites (fire sites and log piles) which are being effectively exploited by both molluscs and plants.

D. *Marginal sites.* The margins of the wood form another broad ecological unit and support additional molluscs which cannot be accepted as truly woodland species. *Monacha cantiana* (Montagu), *Ena obscura* (Müller) and *Hygromia striolata* (C. Pfeiffer) are hedgerow or waste ground species which occur in the

margins and along Hayley Lane. The dry banks of the railway also support some xerophile molluscs like *Vallonia excentrica* Sterki and *Helicella caperata* (Montagu).

E. *Special sites.* Fire sites in the most recent coppice plots (1968/69, 69/70) proved unexpectedly rich in molluscs in September 1970. Both slugs and snails could be found in considerable numbers under burnt, carbonized logs. A careful search of the '69/70 plot demonstrated a clearcut preference for burnt logs. Of 66 individuals found, 63 were under burnt and 3 under unburnt logs. The most likely explanations of this are that burnt logs have a porous texture which retains moisture from dew better than freshly cut wood and they also have a concentration of vital alkalis. One of the three unburnt logs under which snails were found was rotten and spongy and retained moisture like the burnt logs. The other two were lying in rather damper ground.

Since there is no market for timber from the coppice plots in Hayley Wood, piles of logs are left in most cleared sites. These form a second type of special site which is particularly favoured by *D. rotundatus, M. laminata* and larger slugs such as *Arion ater* (L.), *Limax maximus* L. and *Lehmannia marginata.* The snails are almost invariably associated with fallen wood whereas the slugs (except *Lehmannia*) probably use the log piles as shelter but have no real association with them. After a year or two the bark separates from the wood and the resulting gap forms a useful site for egg laying and permanent shelter for small species like *Euconulus fulvus* (Müller), *Oxychilus alliarius* (Miller) and even *Carychium* spp. and *Vitrea crystallina* (Müller) if sufficiently damp.

Asbestos roofing material thrown into the pool at the south-eastern corner of the wood forms another special site which is interesting in that it supports a colony of *Clausilia bidentata* (Ström) unknown elsewhere in the wood except for a single adventive juvenile found at station 72 in May 1971. This colony may be a recent (pre 1966) introduction and the snails show little sign of spreading from the site. Possibly the alkali content of the roofing material is a factor in their survival, although *C. bidentata* is typical of woodlands and occurs in 8 of the 9 other ancient woods visited and both patches of modern woodland.

F. *The triangle.* The drainage behaviour of the triangle differs from that of the main wood and it is difficult to correlate surface moisture between the two, particularly as the ground vegetation is also different. In 1966 the triangle was fairly dry and molluscs were difficult to find. However in December 1970, when the entire wood was very wet, molluscs were found quite commonly even near the north-east corner. Apparently woodland molluscs colonize somewhat faster than the ground vegetation but precisely how fast is uncertain.

FIELD METHODS

1. *Visits.* Five visits were made in 1966 (30 April and four in June) with the main object of collecting from the entire wood and detecting as many species as

possible. Between 20 September 1970 and 12 September 1971 (both dates inclusive) a further 65 visits were made to investigate the ecology of molluscs living within the wood, although some collecting was done along the margins. More than half the visits began between 7.00 and 11.00 a.m. with a second peak between 2.00 and 6.00 p.m. Times of commencement ranged from 5.00 a.m. to 7.50 p.m. and, with respect to daylight, from about 30 minutes before dawn to dusk. No night collecting was undertaken. The normal interval between visits was a week but daily visits were made for some experiments. Timing of the visits covered the entire year and daylight hours adequately to reveal seasonal effects and at least some daytime activities. However as molluscs are largely nocturnal the latter are not very significant. A record of weather conditions was kept at each visit.

2. *Collecting methods.* The main objectives of the 1970–71 collecting included determining which species were present, how they were distributed within the wood, and detecting any plant-mollusc or mollusc-mollusc associations. Attempts were also made to detect life cycles, breeding and hibernation patterns, etc. Some quantitative collecting was undertaken but use of quadrats was rejected as too destructive. To be sure of collecting all molluscs within a quadrat requires excavation to a considerable depth.

Four principal methods of recording were used as follows:—

a. *Stations.* (1–89, Fig. 1). These are specific sites which usually extended over 2–5 m^2. All molluscs collected by hand picking were recorded. For most stations a 30 minute collecting time was adopted. Ground vegetation and site type were recorded for each station. Originally stations were selected to cover the entire wood evenly. After 1 January 1971 stations were selected to cover each vegetation zone adequately and this has resulted in the final rather uneven distribution of stations (Fig. 1).

b. *Bulk samples* consist of one large polythene bag of leaf litter and were collected at 15 stations in addition to the normal hand picking. The samples were dried, sieved through 10, 2 and $\frac{1}{2}$ mm mesh sieves and all molluscs recorded.

c. *Sieve samples* (A–Z, Fig 1) were collected by sieving litter in the field through 2 and $\frac{1}{2}$ mm mesh sieves. Again all molluscs were recorded although only the fine fraction was taken back to the laboratory for examination. Sieve sample sites were selected with reference to migration into the triangle and the distributions of *C. edentula* (Fig. 2), *P. personatum* and, to a lesser extent, *Acanthinula aculeata.*

d. *Random observations* usually involve live active molluscs noticed while moving from station to station. They are particularly useful in detecting widely dispersed species such as the larger slugs.

Each method of collecting has its advantages and disadvantages. Random observations and station collecting tend to favour large and more conspicuous species while bulk and sieve samples favour small species and juveniles. Station collecting involves hand picking and may tend to miss small species. As a check against this 15 bulk samples were collected from selected stations. Tables 1 and 2

show a comparison between bulk sample and station collecting. Rather surprisingly *Retinella radiatula* (Alder), which is by no means the smallest species in the wood, was the most frequently overlooked in station collecting (8 of the 15 stations). This may be due to its very dark colour. When evaluating abundances (Table 3) the bulk sample analysis should be borne in mind. However it may be significant that all species were first detected by hand picking. By using all available methods it is hoped that all molluscs were equally thoroughly studied.

TABLE 1. BULK SAMPLE ANALYSIS

SPECIES	N	SPECIES	N
Retinella radiatula	8	*Vallonia* sp.	1
Carychium tridentatum	5	*Euconulus fulvus*	1
Punctum pygmaeum	4	*Vitrea crystallina*	1
Columella edentula	3	*Oxychilus helveticus*	1
Acanthinula aculeata	3	*Retinella pura*	1
Cochlicopa lubrica	2	*R. nitidula*	1
Arion circumscriptus	1	*Vitrina pellucida*	1
Carychium minimum	1	*Agriolimax laevis*	1
Arion intermedius	1	*A. reticulatus*	1

N. is the number of times (out of 15) that the species listed were overlooked in station collecting.

TABLE 2. NUMBER OF ADDITIONAL SPECIES IN BULK SAMPLES

NUMBER	0	1	2	3	4	5	6
FREQUENCY	2	4	1	3	3	1	1

In all collecting except random observations, a record of the maturity of individuals was kept under the headings 'adult', 'juvenile', 'very juvenile' and some dead shells were also recorded. These categories were defined as follows:—

Adult. In snails which modify the aperture of the shell when mature (e.g. *Helix* spp., *Hygromia plebeia* (Draparnaud), *Cochlicopa lubrica,* etc.) 'adult' was confined to fully mature individuals. With slugs and snails which do not modify the aperture when mature, 'adult' includes the upper third of the size range found in the wood.

Juvenile includes any specimen over one third grown. In snails with modified apertures the upper limit is the onset of the modification. Otherwise 'juvenile' refers to the middle third of the size range.

Very juvenile includes all sizes from just hatched to one third grown.

Dead. This usually implies the discovery of a dead snail shell. In most stations if a live individual of the same species was found subsequently, no further count of

dead shells was made. Evidence of dead slugs in bulk and sieve samples was noted but no attempt was made to identify slugs shells, particularly *Arion* granules. In bulk and sieve samples where all molluscs were killed by drying before counting, evidence of some body material within the shell was accepted as indicating an originally live individual. Such evidence is not easy to detect in species with opaque shells. In all bulk and sieve samples all shells were recorded whether 'live' or 'dead'.

For all stations, bulk and sieve samples the total number of live specimens was divided by the total number of species represented by live individuals to give an average frequency for the sample. Each species was then assigned to one of the

TABLE 3. ABUNDANCE OF SPECIES (STATIONS ONLY)

Species	Total	Dominant	Common	Accessory	Dead
Carychium minimum Müller	23	1	2	16	4
C. tridentatum (Risso)	18	–	4	11	3
Lymnaea truncatula (Müller)	4	–	–	1	3
Planorbis leucostoma (Millet)	1	–	–	–	1
Azeca goodalli (Férussac)	2	1	1	–	–
Cochlicopa lubrica (Müller)	64	–	26	36	2
Columella edentula (Draparnaud)	4	–	–	4	–
Lauria cylindracea (da Costa)	1	–	–	–	1
Acanthinula aculeata (Müller)	18	–	2	16	–
Vallonia costata (Müller)	2	–	–	1	1
V. excentrica (Sterki)	1	–	–	1	–
Ena obscura (Müller)	1	–	–	1	–
Marpessa laminata (Montagu)	44	3	12	28	1
Clausilia bidentata (Ström)	2	1	–	1	–
Helix hortensis (Müller)	7	–	–	4	3
H. nemoralis (L.)	26	–	1	10	15
Hygromia plebeia (Draparnaud)	80	11	32	33	4
Monacha cantiana (Montagu)	3	–	–	–	3
Helicella caperata (Montagu)	2	–	1	–	1
Punctum pygmaeum (Draparnaud)	6	–	1	4	1
Discus rotundatus (Férussac)	57	6	20	29	2
Arion intermedius (Normand)	60	2	10	48	–
A. circumscriptus (Johnston)	47	–	5	42	–
A. hortensis Férussac (agg.)	14	–	1	13	–
A. subfuscus (Draparnaud)	17	–	1	16	–
A. ater (L.)	28	–	5	23	–
Euconulus fulvus (Müller)	40	2	11	27	–
Vitrea crystallina (Müller)	70	5	23	35	7
Oxychilus cellarius (Müller)	40	–	4	34	2
O. alliarus (Miller)	31	1	5	25	–
O. helveticus (Blum)	51	1	13	37	–
Retinella radiatula (Alder)	26	–	5	19	2
R. pura (Alder)	24	–	2	20	2
R. nitidula (Draparnaud)	85	15	33	35	2
Vitrina pellucida (Müller)	28	1	4	16	7
Limax maximus (L.)	5	–	–	5	–
Lehmannia marginata (Müller)	4	–	–	4	–
Agriolimax reticulatus (Müller)	37	–	6	31	5
A. laevis (Müller)	15	–	1	14	–
Pisidium personatum (Malm)	5	–	1	4	–

three following categories:—*Dominant* (more than three times the average frequency), *common* (average to three times average) and *accessory* (less than average frequency). These categories are used to assess the abundance of species within the wood (Table 3) and are also distinguished in the distribution maps (Figs. 4–10).

In addition *Arianta arbustorum* (L.) was found dead and *Pisidium obtusale* Lamarck live in the wood in 1966 but not at any of the 1970–71 stations.

FAUNA

Table 3 is a check list of the molluscs of Hayley Wood together with details of the abundance of each species. The following comments include data which cannot be conveniently summarised in tables and should be read in conjunction with the distribution maps (Figs. 4–10).

Carychium minimum (Fig. 4). An obligatory hygrophile which is fairly widespread but most abundant in ditches beside the NE–SW main ride and, to a lesser extent, the ash swamp zone.

C. tridentatum (Fig. 4). About as widespread as, but less common than, *C. minimum.* Less hygrophilous and hence not dominant in ditches.

Lymnaea truncatula (Fig. 6). Nominally a freshwater species which thrives best in damp muddy ground and avoids standing water. It occurs in vegetated ditches, the SE corner pool (dead) and the temporary stream in the south section.

Azeca goodalli (Fig. 6). *A. menkeana* (C. Pfeiffer) cannot be separated from *A. goodalli* (Férussac) and the latter name is valid (Paul, 1974). Hayley Wood shells are all a rich chestnut brown: var. *crystallina* has not been seen. Most shells have only teeth 1–6 (see Paul, 1974, pp. 157–159) but a few have tooth 7 weakly developed and/or tooth 8. *Azeca* is very local in Hayley Wood and occurs fairly densely in two isolated colonies in the south and east sections. This was the first record of *Azeca* in Cambridgeshire although it is now known from Eversden and Hardwick Woods as well.

Cochlicopa lubrica (Fig. 7). Since Quick (1954) established the differences between *C. lubrica* and *C. minima* (Seimaschko) = *C. lubricella* (Porro), most authors have accepted that two species of *Cochlicopa* occur in Britain. Possibly two more species occur in Europe, *C. nitens* (Gallenstein) which definitely does not occur in Britain, and *C. repentina* Hudec. The latter is apparently distinct anatomically but the shell is said to be intermediate between those of *C. lubrica* and *C. lubricella* except for the white internal rib to the outer lip (Hudec 1960, p. 299). The *Cochlocopa* of Hayley Wood are definitely not *C. lubricella* but neither are they typical of *C. lubrica.* They are rather small (about $5\frac{1}{2}$ mm long), generally have a well marked pink or reddish outer lip and the animal is very lightly pigmented, although very dark specimens occur at stations 11 and 81. Their anatomy is unknown as I was unaware of Hudec's work at the time. The shells lack the white lip said to be characteristic of *C. repentina* and are most probably a small form of *C. lubrica.* The possibility that *C. repentina* may occur in Britain needs investigating as white-lipped shells do occur here.

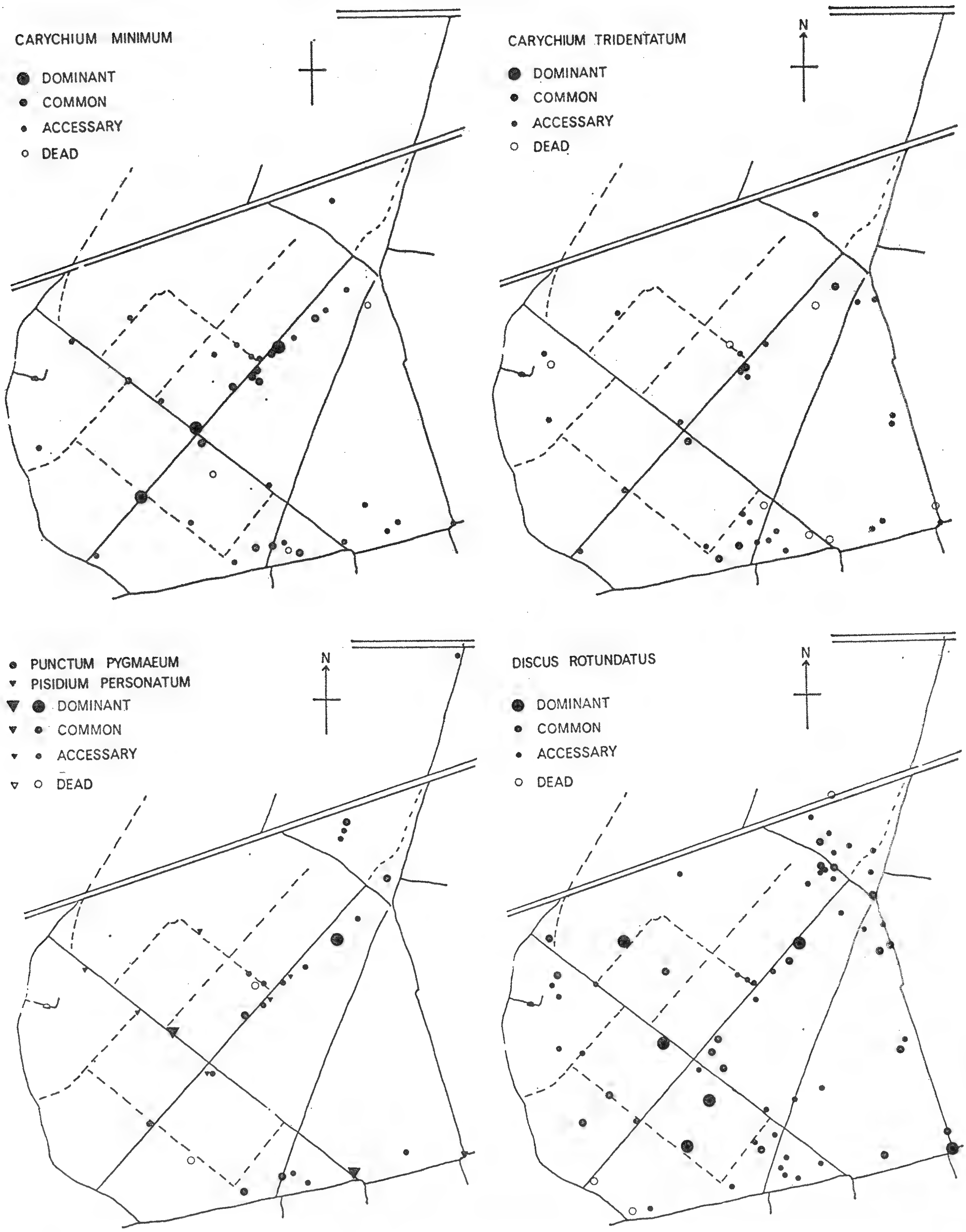


Fig. 4. Distribution maps for *Carychium minimum*, *C. tridentatum*, *Punctum pygmaeum*, *Pisidium personatum* and *Discus rotundatus*.

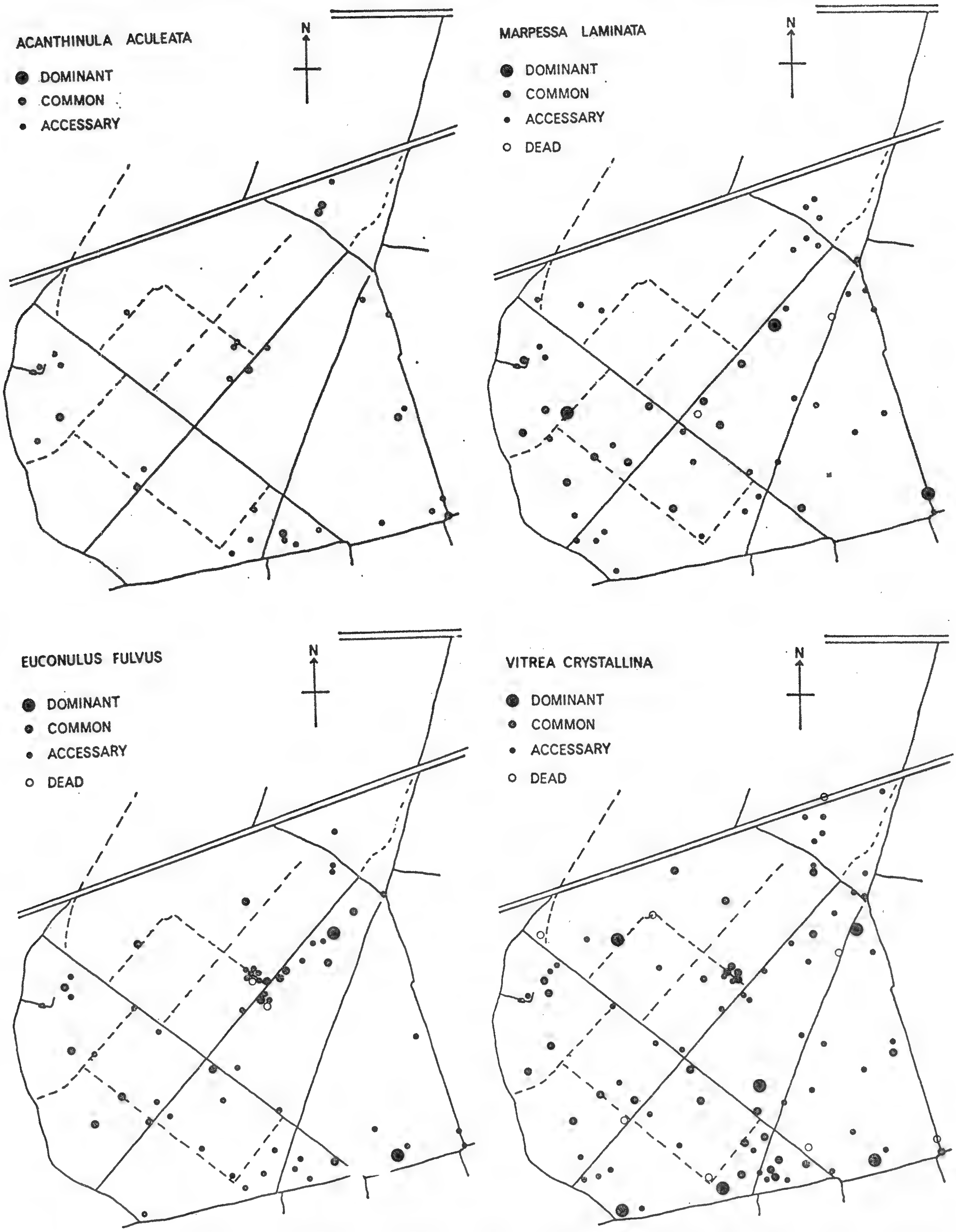


Fig. 5. Distribution maps for *Acanthinula aculeata*, *Marpessa laminata*, *Euconulus fulvus* and *Vitrea crystallina*.

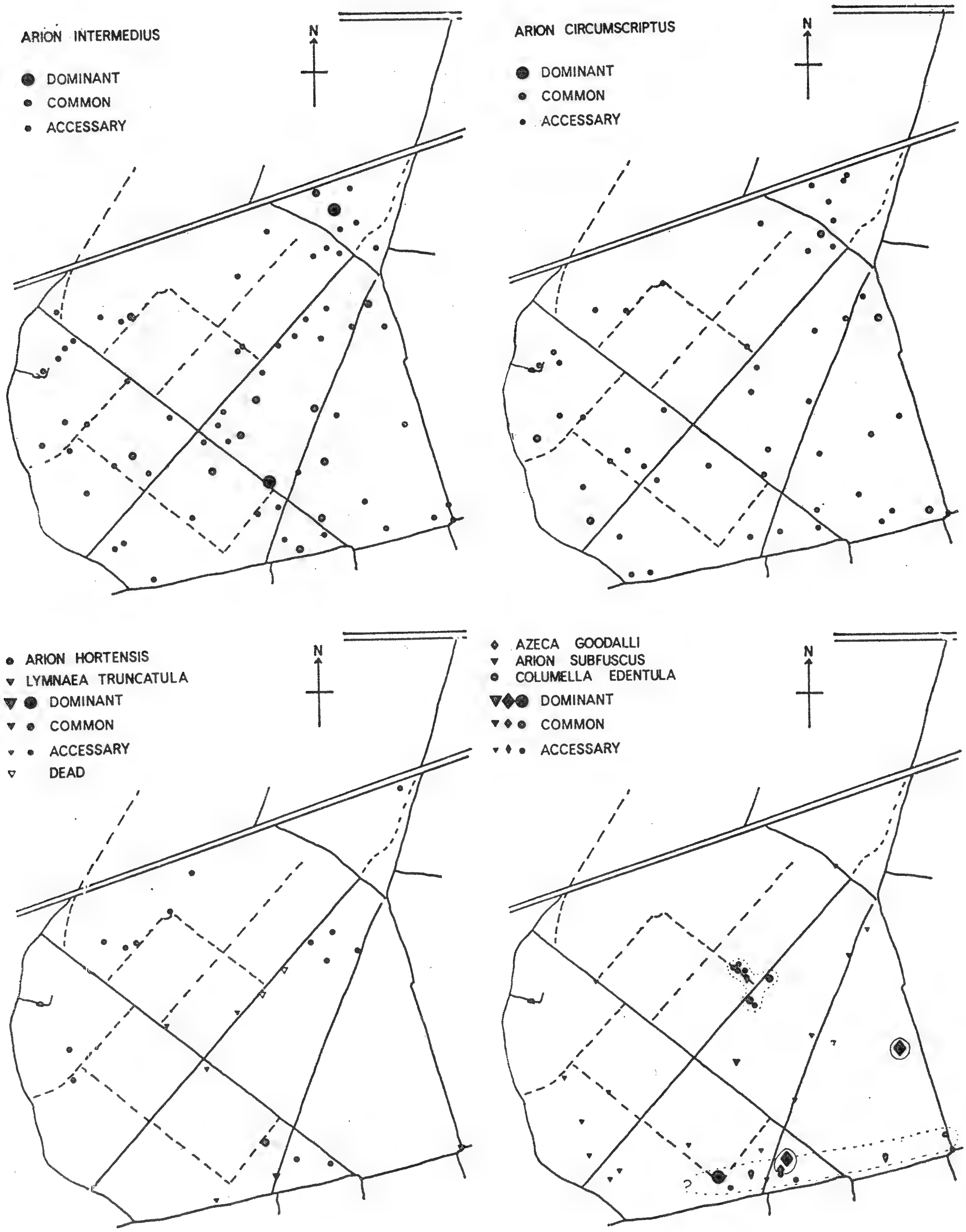


Fig. 6. Distribution maps for *Arion intermedius*, *A. circumscriptus*, *A. hortensis*, *A. subfuscus*, *Lymnaea truncatula*, *Azeca goodalli* and *Columella edentula*. Broken lines in lower right map indicate probable limits of *C. edentula*; solid lines, probable limit of *A. goodalli*.

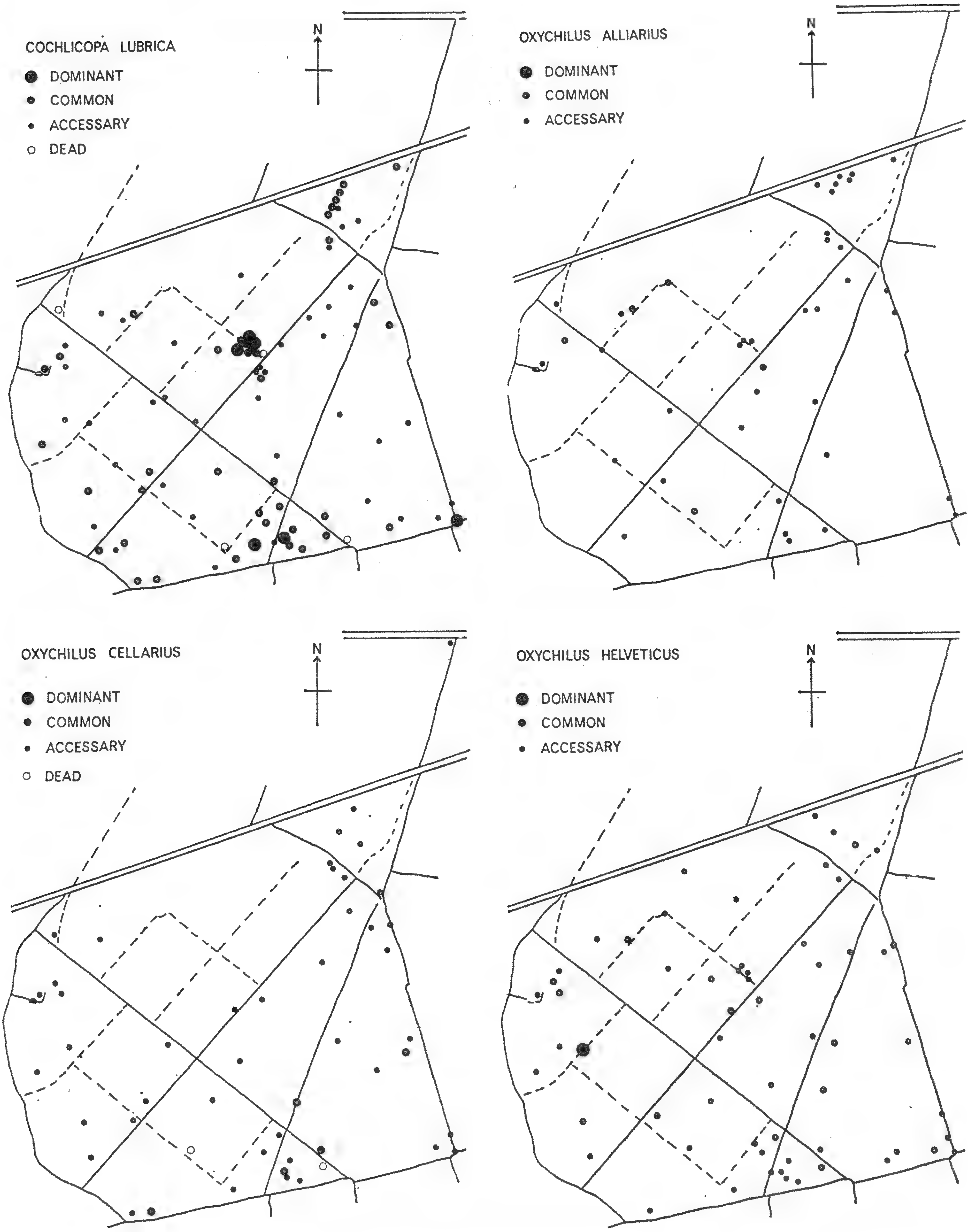


Fig. 7. Distribution maps for *Cochlicopa lubrica*, *Oxychilus alliarius*, *O. cellarius* and *O. helveticus*.

C. lubrica is abundant and widespread in Hayley Wood. In dry weather it is very difficult to find and apparently burrows in the soil. Before 19–11–70 it was only found as an accessory species but during the damp winter and spring months it was found much more commonly. Adults hibernate in winter with an epiphragm across the aperture but the juveniles remain active. Egg clusters hatch in September and are responsible for the apparent dominance in the *Carex riparia* zone (Fig. 1): large numbers of just hatched individuals being found in sieve samples. The main centre of distribution is the ash swamp zone and adjacent areas. The apparent commonness in the triangle is partly due to the low numbers of other species.

Columella edentula (Figs. 2, 6). *C. aspera* Waldén which prefers more oligotrophic and acid habitats (Waldén, 1966, p. 54), is not found in Hayley Wood. *C. edentula* is strongly associated with *Carex* spp and damp sites. It occurs quite commonly in two areas: among *Carex riparia* in the north and east sections (Fig. 2) and among *Carex sylvatica* and ash litter in the ash swamp zone. Ash litter forms rich alkaline soils which *C. edentula* prefers but there is no constant association between the two in Hayley Wood. Ash trees occur all over the wood but *C. edentula* does not. Equally there is no constant association of *C. edentula* and *Carex* spp. *Carex sylvatica* occurs throughout the wood but *Carex riparia* is confined to the areas shown in Fig. 2. *C. edentula* occurs with *Carex sylvatica* only in the ash swamp zone and with *Carex riparia* only outside the ash swamp zone. One can only conclude that is the combination of Ash litter, *Carex* spp. and continuous dampness which is necessary for the survival of *Columella* in Hayley Wood. *Carex riparia* is spreading into the coppice plots and the northern colony of *Columella* is as well. For the distinction between *C. aspera* and *C. edentula* see Paul (1975).

Lauria cylindracea. A single dead shell found at station 72.

Acanthinula aculeata (Fig. 5). Fairly widespread but not very common. Very difficult to find in dry weather in autumn: only one live adult was seen prior to Christmas 1970, thereafter it was found quite commonly. Like *Vitrina pellucida,* its main period of activity is during winter and it apparently does not hibernate at all. However, unlike *V. pellucida* the adults do not necessarily die off in spring and may well live for two years. Bulk sample analysis shows that it is not very frequently overlooked (Table 1).

Vallonia excentrica and *V. costata.* These are open site species found living on the railway embankment and field margins at the southeast corner. Neither lives in the wood.

Ena obscura. A hedgerow species found living at station 70 on Hayley Lane.

Marpessa laminata (Fig. 5). Widespread and fairly abundant but apparently rarer in the north section. A typical woodland species which feeds on fungi growing on rotten wood. Its apparent absence from the north section may indicate that it requires good vegetation cover. All specimens seen before 1–11–70 were on fallen wood but thereafter hibernating specimens were found on the ground. Worn

and unworn adult specimens which occur together suggest that *Marpessa* can live for at least two years. *M. laminata* can move about ½ m overnight.

Clausilia bidentata. Apart from an adventitious juvenile found at station 72, *C. bidentata* is confined to a small area immediately around the southeast corner pool (station 11).

Arianta arbustorum. Despite its name, *A. arbustorum* is not typical of woods in Britain. A single dead shell was found in the south section glade in 1966.

Helix hortensis (Fig. 10). Apparently quite widespread but uncommon. It occurs in two main band forms: bandless with a pinkish or brown lip (identification confirmed by dissection of darts) or five-banded with a white lip. *H. hortensis* is apparently preyed on by a small mammal which left a pile of damaged shells under a hazel bush along the south margin of the wood. This pile contained about equal numbers of both band forms.

Helix nemoralis (Fig. 10). Slightly more common than *H. hortensis* and equally widespread. Apparently both species avoid the bare ground of the north and east sections. Since they feed on higher green plants they presumably prefer the richer vegetation zones which also provide better protection from predators. The apparent abundance of dead shells may not indicate that these two species are dying out. The shells are large, easily spotted and more durable when dead than those of smaller species. Even so it is difficult to explain the concentration of dead shells in the south and west. Both species are probably favoured by coppicing.

Hygromia plebeia (Figs. 10, 11). Probably the most interesting species in the wood. The shell varies from almost colourless and translucent to chestnut brown and the animal from white to black. White animals in colourless shells resemble *Ashfordia granulata* (Mont.) and are well camouflaged in areas of dead sedge and grass. Dark animals in colourless shells have a slate to bluish grey appearance and are well camouflaged against a bare soil background. Individuals with brown shells merge into leaf litter backgrounds. The shell shape varies very little: all shells are conical with a narrow umbilious typical of what some British authors have called *Hygromia liberta* (Westerlund) (Fig. 11a–c). However, Westerlund described *H. liberta* on the basis of some globular specimens of *H. hispida* (L.) from near Lund, Sweden (Waldén, personal communication after examination of the type material). Wiktor (1964) figures the shell and genital anatomy of *H. sericea* (Drap.) [= *H. plebeia* (Drap.)] both of which agree with the Hayley Wood material (Fig. 11). In comparison with typical *H. hispida,* the shell of *H. plebeia* is more conical, has a narrower umbilicus and a much broader body whorl which frequently turns down at the aperture. The genital anatomy is generally more robust, especially in the female tract, and the mucous glands are relatively slightly shorter than in *H. hispida* (cf. Figs. 11H and I). Unfortunately all British *Hygromias* of the *hispida* complex do not fall into just two shell variants. *H. hispida* shows a size trend which is correlated with the degree of exposure of the site in which it lives. Specimens from chalk or limestone hills with short grass cover are very small (var. *nana, c.* 5 mm diameter), specimens from hedgerows and waste ground are larger still (6–7 mm diameter) and colonies of very large

individuals occur in suitably rich habitats (up to 10 mm. diameter). All these have the open umbilicus and narrow body whorl typical of *H. hispida* (Figs. 11D, E). Despite these size and shape variations within *H. hispida,* the form of *Hygromia* living within Hayley Wood and other ancient woods in the area, is apparently quite distinct from *H. hispida* and may well be synonymous with the European *H. plebeia.* Smaller shells with a similar shape do occur outside woodland but their anatomy is unknown and I do not think they represent *H. plebeia. H. plebeia* has a Midlands distribution in England: certainly it is absent from all woodland that I examined in north Hampshire and Berkshire during 1971–73.

H. plebeia is the second most abundant species in the wood (Fig. 10). Most specimens mature in late autumn and may die during the winter but no definite breeding season was detected. *H. plebeia* can move about 1 m overnight and is preyed on by birds. It is very active and the fauna of one square metre is replaced on average every 1–3 days.

Monacha cantiana. A species of field margins and hedges found dead along the railway embankment, in Hayley Lane between the railway and the road, at the southeast corner and just within the wood at station 89. Not a woodland species.

Helicella caperata. A xerophile species of open fields and downland. Found living on the railway embankment and a single dead shell at station 13. Not a woodland species.

Punctum pygmaeum (Fig. 4). The smallest British snail and easily overlooked (Table 1). Apparently tolerant of very wet sites and with a distribution similar to those *Carychium* spp. Not common in the main body of the wood but possibly more widespread than the records suggest.

Discus rotundatus (Fig. 4). Very common and widespread, associated with fallen wood. A greenish variety occurs rarely. *D. rotundatus* apparently avoids the thinnest ground cover of the north section and has spread into the triangle only a little further than the ground vegetation.

Arion intermedius (Fig. 6). In Hayley Wood this slug is predominantly greenish yellow with pale yellow bands on the sole of the foot. The tubercles are more prominent than in other species so that it looks 'prickly' when at rest and is often called the hedgehog slug. After frost the animals look sickly and have less obvious tubercles but the frosts did not appear to kill them. Rarely *A. intermedius* adults show traces of the darker lateral bands found in other species of *Arion. A. intermedius* is the commonest and most widespread slug in the wood but tends to be rather dispersed as do all slugs and the largest snails (*Helix* spp.). Apparently *A. intermedius* spread into the triangle from the main wood. It avoids extremely wet sites.

A. circumscriptus (Fig. 6). Three species have been confused under this name. One, *A. fasciatus* Nilsson, has yellow pigment whereas *A. silvaticus* Lohmander and *A. circumscriptus s.s.* lack this colour. *A. silvaticus* is smaller than *A. circumscriptus,* has white sides and darker lateral bands. It can contract more than *A. circumscriptus* and does not rest with the bell-shaped cross section

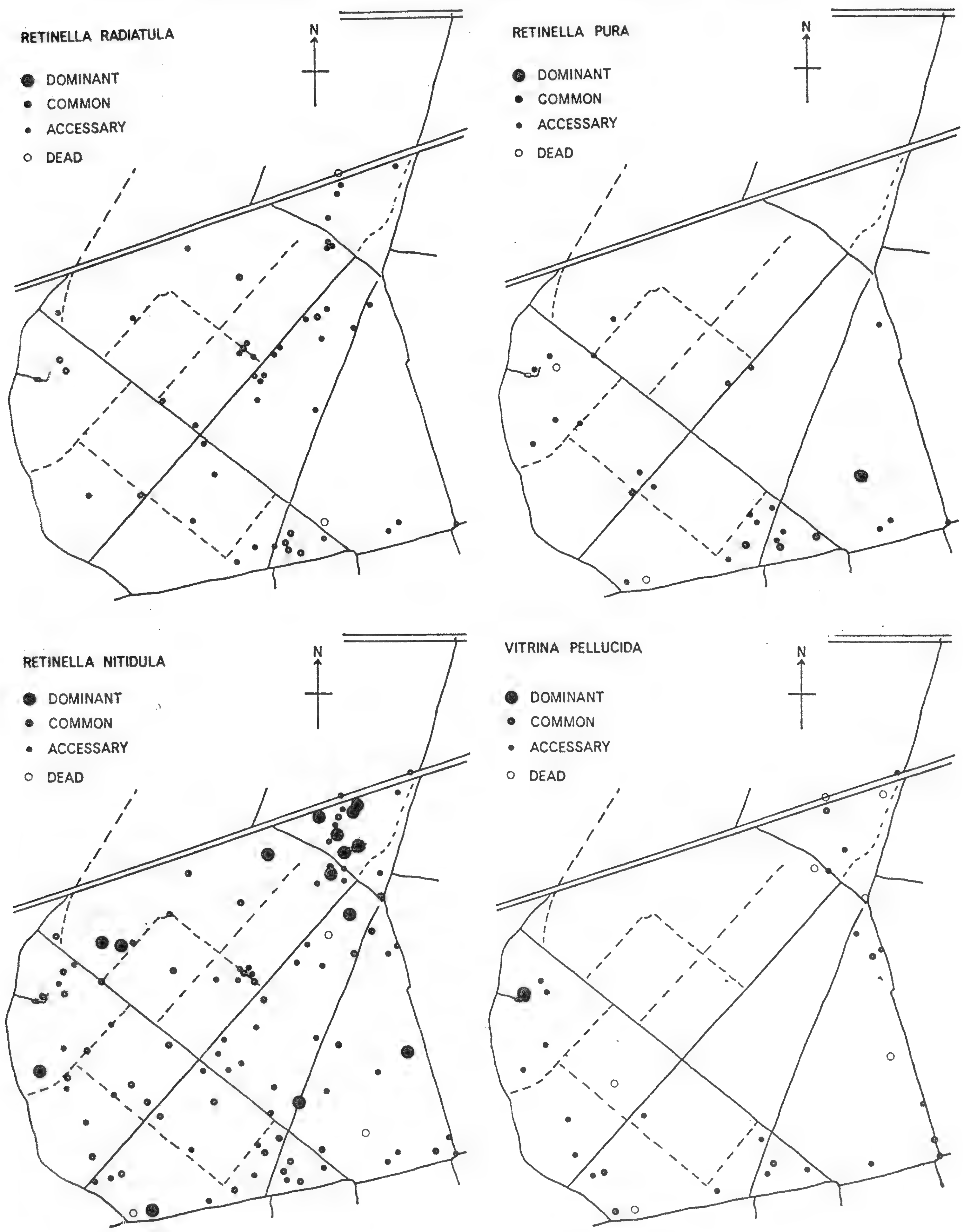


Fig. 8. Distribution maps for *Retinella radiatula*, *R. pura*, *R. nitidula* and *Vitrina pellucida*.

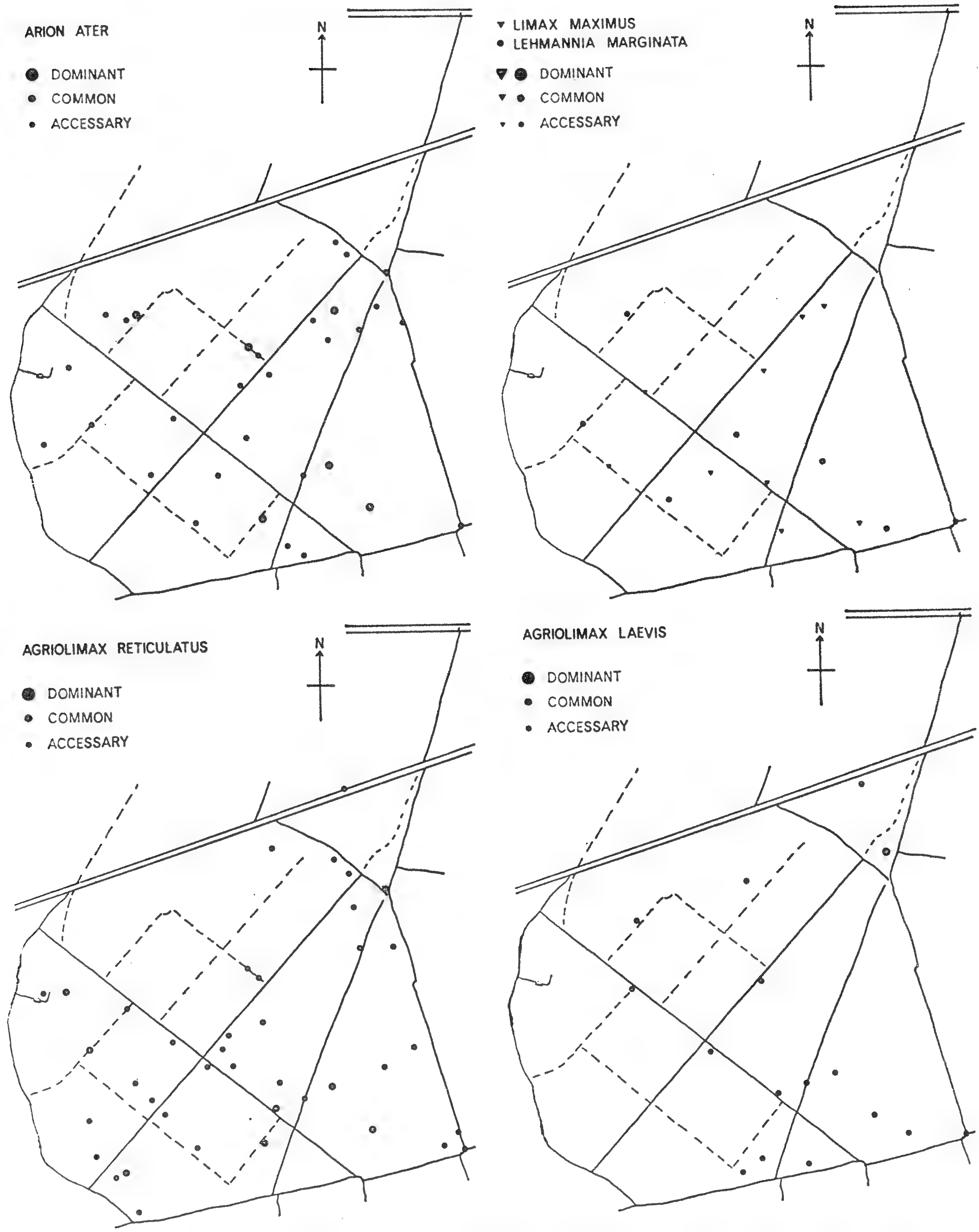


Fig. 9. Distribution maps for *Arion ater, Limax maximus, Lehmannia marginata, Agriolimax reticulatus* and *A. laevis.*

of the latter. *A. circumscriptus* has grey sides and less distinct lateral bands than *A. silvaticus.* Only *A. circumscriptus s.s.* occurs in Hayley Wood and, in my experience, it is typical of woodland at least in East Anglia. It is fairly common and widespread in the wood, apparently less so in the north section. For further details of the differences between the species in the *A. circumscriptus* complex see Lohmander (1937) and Waldén (1955).

A. hortensis (Fig. 6). Recent unpublished work by Miss S. M. Davies indicates that three species have been confused under this name also. One of these (form B) is larger and has more prominent tubercles. It resembles a large, dark and banded form of *A. intermedius* and frequently has bright yellow bands on the sole. This species certainly does not occur in Hayley Wood and is apparently very rare in southern England, although not uncommon in the western part of southern Scotland (Kerney, 1974). The other two species are best distinguished on anatomy and breeding pattern. Form A, which lacks red pigment and has a spring breeding season, has been found in Madingley and Hardwick Woods but as yet I do not know which form occurs in Hayley Wood. The distribution of *A. hortensis* within the wood is puzzling: apart from an isolated occurrence in the triangle which could easily have migrated in from the railway, it occurs in four discrete clusters, one in each section of the wood. *A. hortensis* is widely associated with man and one wonders if these clusters represent distinct introductions. Even so it is surprising that this very successful agricultural and garden pest has not invaded the entire wood.

A. subfuscus (Fig. 6). This species is generally rare in East Anglia and only one other site besides Hayley Wood is known in Cambridgeshire (Bishop, 1974). It is more common in the southern half of the wood. Possibly there are two distinct species confused under this name but this is not yet established. When adult the Hayley Wood slugs are a rich chestnut to ginger brown with darker lateral bands. Only the juveniles show any trace of the dirty grey colour common in adults from western Britain.

A. ater (Fig. 9). The largest British *Arion.* In Hayley Wood juveniles are a delicate pale orange colour and bandless. Adults are black and the change appears to take place very rapidly. A few specimens were dissected by Mr. A. E. Ellis and appeared to be slightly immature *A. ater s.s.* However it is becoming increasingly doubtful as to whether *A. ater* and *A. rufus* L. are really distinguishable in Britain. *A. ater* is quite widespread and its distribution shows some traces of the pattern found in *A. hortensis.* Certainly it occurs in all the areas where *A. hortensis* is found.

Euconulus fulvus (Fig. 5). The variety *alderi* is probably a distant species typical of very wet habitats whereas *fulvus s.s.* is typical of woodlands. Both forms occur together in intermediate habitats such as wooded floodplains of rivers. The shell of *E. fulvus* differs from that of *E. alderi* in having a silky upper surface (*alderi* is shiny), generally a greater spiral angle, keeled whorls even in the juvenile shell and less obvious or absent spiral lines on the under surface. *E. alderi* has beauti-

fully regular spiral lines. In *E. fulvus* the animal is rarely darkly pigmented except for the mantle collar and the shell is a paler yellow brown. The animal of *E. alderi* is usually black all over and the shell one or two shades darker than that of *E. fulvus.* Only *E. fulvus s.s.* occurs in Hayley Wood where it is very common and widespread, although it apparently avoids the less vegetated areas of the north and east sections. It is also rare in the triangle. *E. fulvus* likes damp areas and is not seriously affected by coppicing. Specimens from Hayley Wood and elsewhere in southern England have a rich silky upper surface: the periostracum has very many closely spaced colabral (i.e. parallel to the lip) ridges. Specimens from northern England and southern Scotland are much less obviously silky and generally have thinner shells.

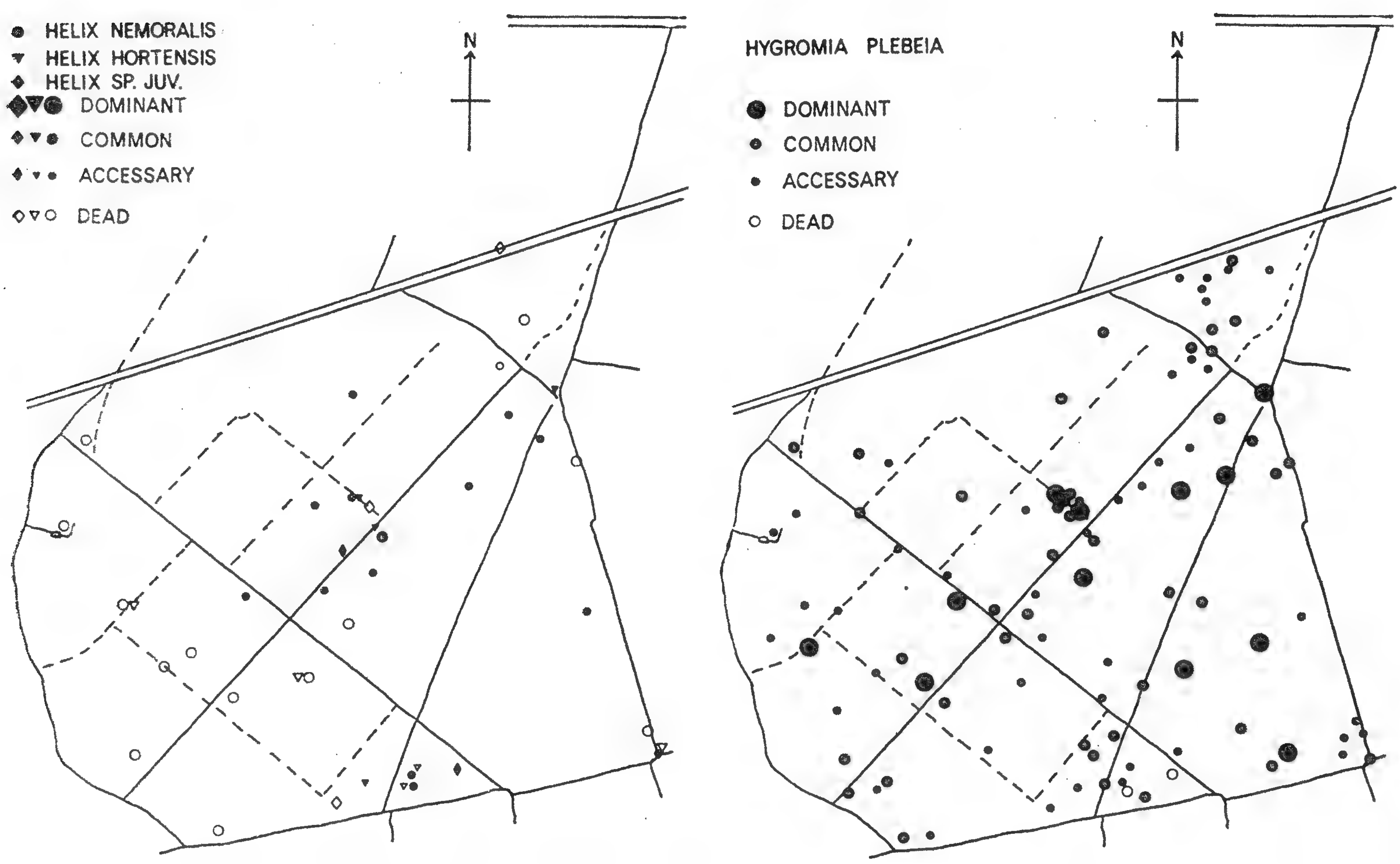
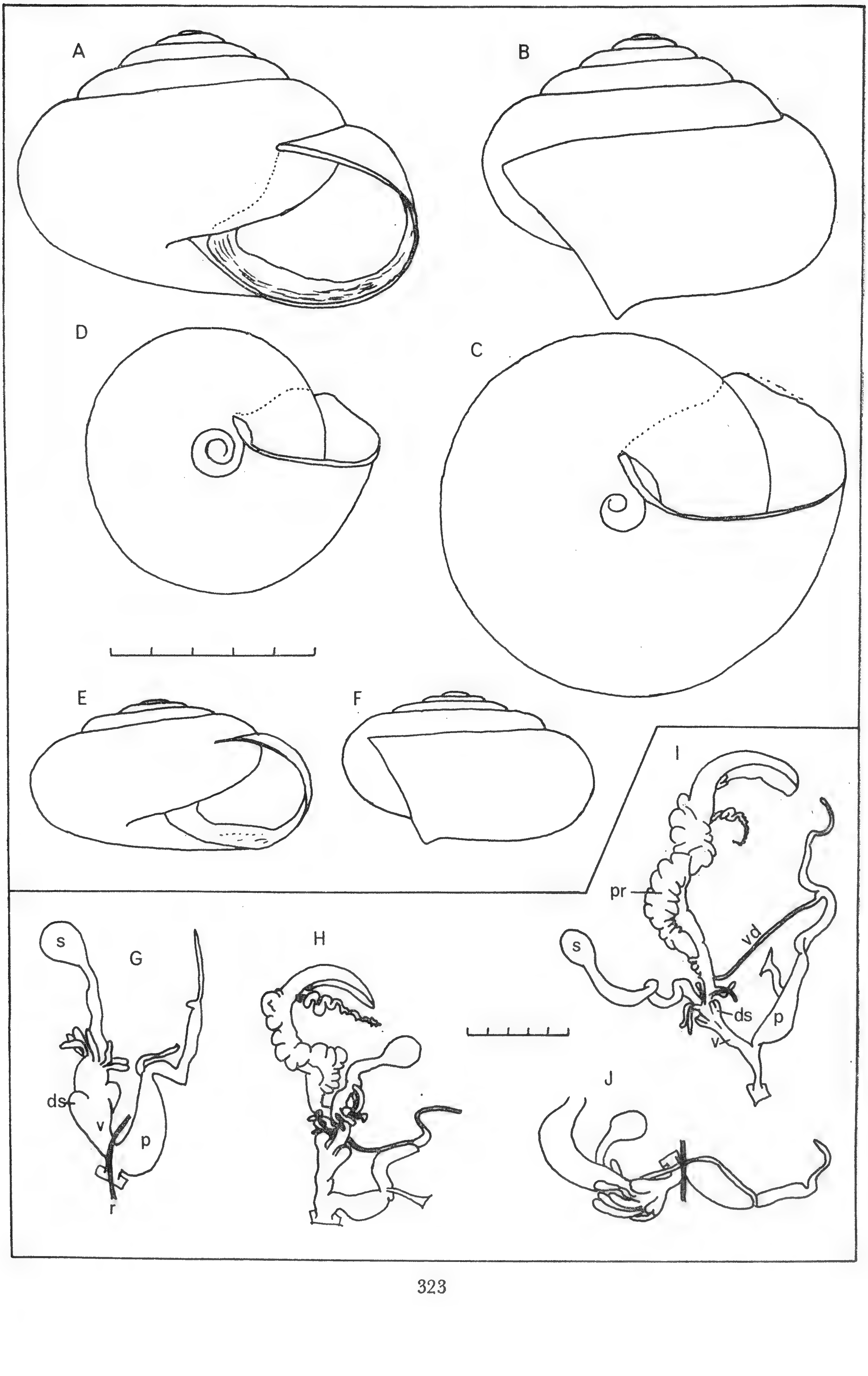


Fig. 10. Distribution maps for *Helix* (*Cepaea*) *nemoralis*, *H.* (*C.*) *hortensis* and *Hygromia* (*Trichia*) *plebeia*.

Fig. 11. Shell and anatomy of *Hygromia* (*Trichia*) *plebeia* and *H.* (*T.*) *hispida*. A-C Camera lucida drawings of the shell of *H.* (*T.*) ?*plebeia*, Hayley Wood, Cambridge. D-F Camera lucida drawings of the shell of *H.* (*T.*) *hispida* var. *nana*, Gog Magog Hills, Cambridge. The size difference is insignificant but note the flatter shell, relatively more open umbilicus and proportionately smaller aperture in *H.* (*T.*) *hispida*. G. Camera lucida drawing of the lower reproductive tract of *H.* (*T.*) ?*plebeia*, Hayley Wood, Cambridge. H. Reproductive anatomy of *H.* (*T.*) *plebeia*, Zieleniec, Poland. I. Camera lucida drawing of the lower reproductive tract of *H.* (*T.*) *hispida*, Woodenbridge, Co. Wicklow, Eire. J. Reproductive anatomy of *H.* (*T.*) *hispida*, Ladek Zdrój, Poland. (H and J redrawn from Wiktor 1964, fig. 12, p. 81).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Vitrea crystallina (Fig. 5). Three species of *Vitrea* occur in Britain (Kuiper, 1964; Kerney and Fogan, 1969). Of these only the hygrophilous *V. crystallina* occurs in Hayley Wood where it is very common and widespread even in the triangle. *V. contracta* might be expected on the railway embankments or field margins but was not detected by my brief collecting.

Oxychilus cellarius (Fig. 7). In Hayley Wood *O. cellarius* is always pale coloured with the animal scarcely pigmented at all. It is widespread but rather solitary and apparently less common in the north section. I have never succeeded in provoking a garlic smell from this species.

O. alliarius (Fig. 7). In Hayley Wood *O. alliarius* is usually fairly darkly pigmented and is fairly widespread but not very common. Apparently it spread into the triangle from the railway not the main wood. When irritated *O. alliarius* produces a strong garlic odour.

O. helveticus (Fig. 7). The most common and widespread of the three *Oxychilus* species found in the wood. More gregarious than the other two species but only dominant at one site. Pigment is confined to the mantle collar which helps in separating it from *O. alliarius. O. helveticus* also produces a garlic odour which is subtly but distinctly (and quite indescribably) different from that of *O. alliarius.*

Retinella radiatula (Fig. 8). Common and fairly widespread. Usually fairly darkly pigmented (the white form is unknown in the wood) and the most frequently overlooked species in station collecting (Table 1). It is quite likely to be more widespread than Fig. 20 suggests.

R. pura (Fig. 8). Uncommon outside the south and west sections and with a distribution very much like that of *Vitrina pellucida,* perhaps associated with the richest ground vegetation. In Hayley Wood *R. pura* occurs equally frequently with yellow-brown or pale greenish-white shells. There is apparently no taxonomic or ecological significance in these variants.

R. nitidula (Fig. 8). The most widespread and abundant species in the wood, even in areas which other species shun such as the triangle and the north section. In these areas the absence of other species tends to make *R. nitidula* dominant but this is not entirely due to lack of competition and it is genuinely very common in the triangle. *R. nitidula* can move about 60–70 cm overnight. It is a scavenger and has been observed eating other snails (usually *Oxychilus* spp.), which may account for its apparent independence of the ground vegetation. Very rarely greenish shelled examples occur. *R. nitidula* is a very catholic species not confined to woods.

Vitrina pellucida (Fig. 8). Most of the specimens from within the wood have unusual mauvish coloured bodies and many have a mantle flap which extends over much of the spire when the animal is active. On dissection they proved to be *V. pellucida* and not the rarer *V. major* which has a darkly pigmented body but more bluish-black in colour. *V. pellucida* from the southeast corner pool (station 11) were uniformly white and unpigmented. *V. pellucida* is not uncommon in the south and west sections. It is also a marginal species along Hayley Lane and in the triangle. Within the wood its distribution is very similar to that

of *Retinella pura*. *V. pellucida* has a strongly seasonal breeding pattern. Adults are most active in winter and do not hibernate. They lay eggs in late March or early April and all die by mid April. Only two live adults were seen on 14–4–71 and none thereafter. The first juveniles were found on 9–5–71.

Limax maximus (Fig. 9). Probably the largest slug in the wood, reaching 120 mm when fully extended. Both the common spotted form and the uniformly grey melanistic form occur. It is probably more common than the distribution map indicates although as each animal requires a large grazing area it should be much less common than smaller species. *Limax maximus* is said to feed on fungi but I was unable to confirm this.

Lehmannia marginata (Fig. 9). Also a large fungus eating slug and rather rare. Hayley Wood is the only known site in Cambridgeshire. It is occasionally found in aggregations under the bark of fallen wood. One or two uniformly white adults were found in the west and south sections but most are mottled and heavily pigmented. Juveniles have the characteristic lyre-shaped bands over the mantle and head. Again it is probably somewhat more common than the map indicates.

Agriolimax reticulatus (Fig. 9). Most specimens from Hayley Wood are typically mottled grey-brown but a few very darkly pigmented bluish-black individuals occur. *A. reticulatus* is fairly widespread but rather solitary like the large slugs. Coppicing probably favours this field slug by increasing the growth of herbs.

A. laevis (Fig. 9). Markedly hygrophilous and hence it tends to occur in ditches and other damp sites. In Hayley Wood it is usually a milk-chocolate brown and is moderately widespread but not common.

Pisidium personatum (Fig. 4). A minute freshwater bivalve which can survive in barely damp locations. Not uncommon in vegetated ditches and pools but not present in stagnant pools filled with oak and hawthorn leaves. In Hayley Wood, as elsewhere, the shells are frequently stained brown with iron deposits.

P. obtusale. Live specimens were found together with *P. personatum* in June 1966 at one site on the path which runs NW–SE in the north section.

DISCUSSION

A few points call for comment. First in assessing the distribution maps it is essential to realize that the categories 'dominant', 'common' and 'accessory' are determined by relative abundance at the site and not by absolute numbers. It is possible for the same number of specimens to be 'dominant' at one site but only 'common' at another. Secondly, the larger the sample the more reliable the data. As sieve samples were generally the smallest samples these are correspondingly less reliable. Thirdly all samples are subject to bias due to seasonal factors. Some species are exceedingly hard to find in dry weather. Hatching of egg clusters produces large numbers of young individuals, particularly in sieve samples. This has resulted in the apparent dominance of *Cochlicopa lubrica* in the *Carex*

riparia zone of the north section. Finally species with a seasonal breeding pattern lasting one year, for example *Vitrina pellucida,* can only be found as dead shells at certain times of year. Since only live specimens are included in the abundance categories again the samples will be slightly biassed. Taking relative abundance at each site has two advantages. First it indicates which species are best adapted to the local conditions at the site. Secondly it enables results from different types of samples (e.g. sieve samples and station collecting) to be presented on the same map with only a small number of symbols and without any bias due to the sample type. Since sieve samples were usually smaller than station samples, they would normally have lower absolute numbers of specimens. In practice the method seems to have produced results which might have been predicted. For example *Carychium minimum,* an obligatory hygrophile, although fairly widespread is dominant in ditches and common in the ash swamp zone. *C. tridentatum* which is somewhat more tolerant of drier conditions, is never dominant in ditches and very slightly more widespread. Not all the distributions are entirely related to surface moisture however and other factors need to be considered.

Decaying vegetation contributes both bases and 'humic' acids to the soil. Different plants produce different ratios of base to acid. Generally ground herbs have more base than acid and produce rich alkaline soils. Of the trees, this is also true of ash but oak and hawthorn produce neutral to acid residues whereas beech and pine (both absent from Hayley Wood) produce strongly acid residues. Secondly as a broad generalization, the longer the leaves etc. take to decay the more acid the residue. Hayley Wood lies on a chalky boulder clay soil which is highly calcareous and caps hills over 200 ft. (62 m) in west Cambridgeshire. Much of the north section of the wood is very level and pools form in winter. Leaves which are resistant to decay tend to be blown into these pools and form local accumulations which if not acid (no pH determinations were available to me) are certainly most inhospitable to molluscs. For example sieve sample l was taken from one such pool and produced no molluscs at all, nor did sieve sample k which came from a ditch full of oak and hawthorn leaves. The common occurrence of such leaf accumulations together with sparser ground herbs may account for the relative scarcity of almost all molluscs in the north section. In contrast most of the west section and south parts of the east and south sections slope quite gently, are well drained and have a denser ground flora. Furthermore surface water drains off this slope but is prevented from leaving the wood by an earth bank several metres wide and up to $1\frac{1}{2}$ m high which runs along the south margin of the wood. Nutrients brought down by surface water must accumulate in the ash swamp zone and this may partly account for the occurrence of *Columella edentula* in this area.

Although wetter in winter the north section and central parts of the east section have relatively sparse ground vegetation and become dry in summer. One would expect molluscs sensitive to dry conditions to occur more commonly elsewhere. *Marpessa laminata, Retinella pura, Vitrina pellucida* and the slugs *Arion subfuscus, A. intermedius* and *A. circumscriptus* appear to have this type of distribu-

tion. Even very widespread species such as *Cochlicopa lubrica* and *Hygromia plebeia* are less common in the north section.

One serious omission of this study is that no systematic attempt was made to determine the food of molluscs living in the wood. It is not possible to be certain whether any mollusc distribution is correlated with suitable food sources although this seems unlikely. If species living within the wood have the same general diet that they have in other areas, then all over the wood there is adequate food available for all but a few of the larger species which feed on vascular plants. These species, *Helix* spp., *Arion ater* and *Agriolimax reticulatus,* might be less common in the north and central east sections due to the relatively sparse ground flora.

ACKNOWLEDGMENTS

I would like to thank the Cambridgeshire and Isle of Ely Naturalists' Trust for permission to work in Hayley Wood and, in particular, Dr. O. Rackham for inviting me to study molluscs in the wood and for useful discussion of historical and botanical aspects of the work. Mr. A. E. Ellis and Miss S. M. Davies kindly confirmed the identification of some of the slugs and Dr. M. P. Kerney identified the *Pisidium* species.

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APLYSIA PARVULA GUILDING IN MÖRCH, AN OPISTHOBRANCH NEW TO THE BRITISH FAUNA

Alan Bebbington and Gregory H. Brown
Zoology Department, University of Bristol

(*Read before the Society, 19 October 1974*)

INTRODUCTION

On 15 June 1974 a small aplysiid was found on a holdfast of *Laminaria digitata* whilst working at a depth of 6 m (high water, neap tide) at Watermouth Cove just east of Ilfracombe, N. Devon. A second and larger specimen was collected by another diver at the same time. These proved to be the first British records of a circumtropical species *Aplysia parvula* Guilding in Mörch, 1863.

DESCRIPTION

The specimens in life measured 12 mm and 34 mm in length and weighed 0·05 g and 0·9 g respectively. *Aplysia parvula* is small when compared with other aplysiid species and rarely reaches more than 60 mm in length (Eales, 1960).

In life the specimens were greeny-brown in colour which on closer examination was made up from small brown blotches on a paler background. The cephalic tentacles, rhinophores, parapodia, anal siphon, mantle and tip of the tail were bordered with black.

The external features of *Aplysia parvula* are shown in Fig. 1. Baba (1949) gave a coloured illustration of a live Japanese specimen and McGregor (1974) includes a coloured photograph of a Great Barrier Reef specimen.

The head and neck were capable of great expansion and the narrow foot ended in a pointed tail. The cephalic tentacles and rhinophores were black in their folded portions; the rhinophores being split for about two-thirds of their length (Fig. 1B). The eyes were small, dark, and each lay in a small patch of paler skin.

The parapodia were widely spaced in front and joined high up posteriorly. The mantle foramen (Fig. 1A) was large and the shell was clearly visible through the aperture. The shell (Fig. 2B) was slightly longer than it was broad measuring 10 mm × 6 mm in the 34 mm specimen. The central portion of the shell was calcified and the periphery flexible. The spiral apex was clearly visible in a ventral view (Fig. 2C). The opaline gland was multiporous and when the large specimen was irritated this produced a milky secretion which was mixed with purple dye from the mantle glands. The gill was a lobate plume-like structure attached to the floor of the mantle cavity with its free portion projecting backwards.

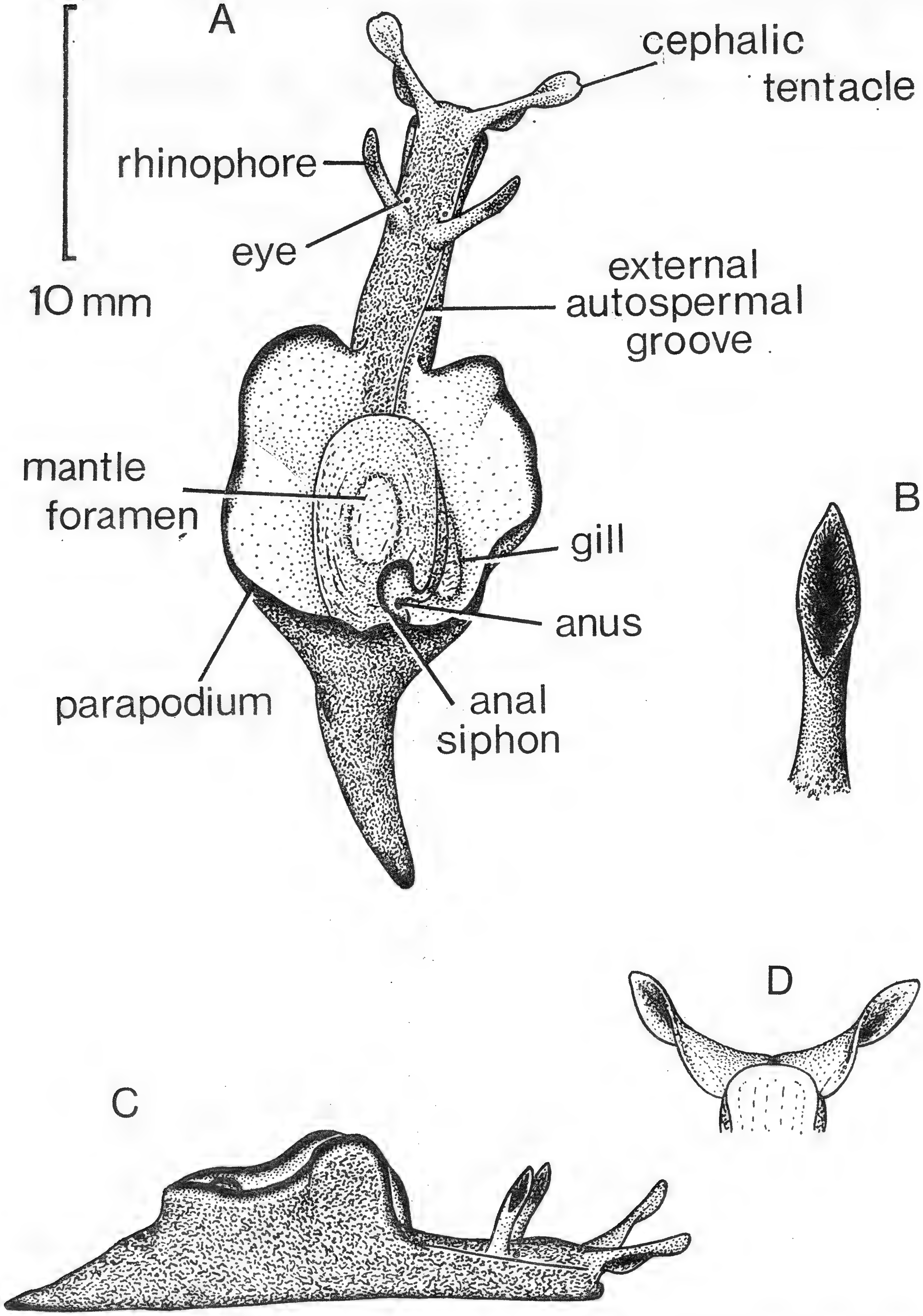

Fig. 1. *Aplysia parvula* from Devon, drawn from life, which measured 34 mm in length, body-weight 0·9 g: A. dorsal view, B. detail of rhinophore, C. right lateral aspect, D. ventral view of anterior end.

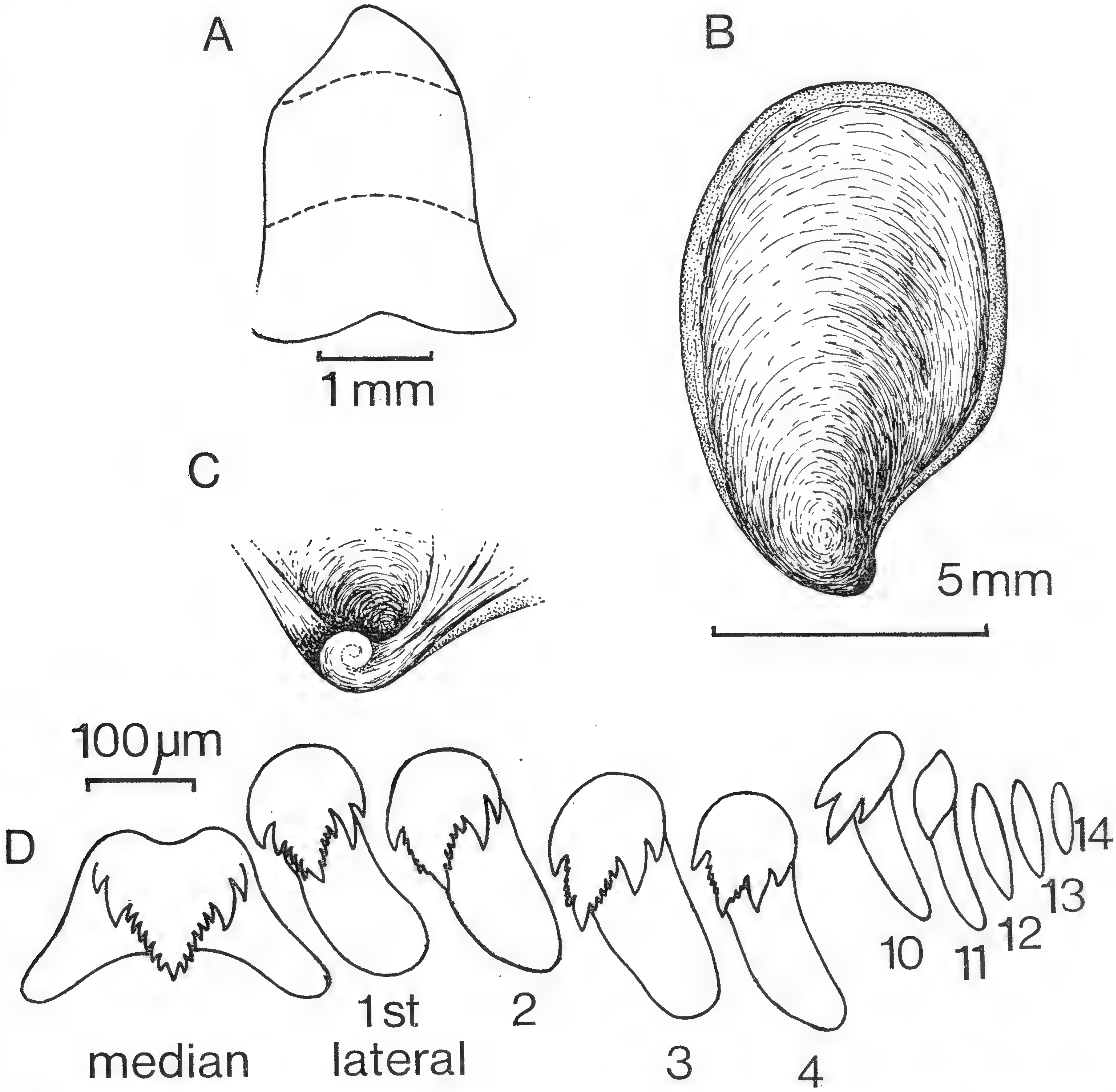

Fig. 2. *Aplysia parvula:* A. outline of the radula when mounted flat on a microscope slide—the dotted lines represent every tenth row of teeth from the posterior end, B. dorsal view of shell, C. ventral view of posterior part of shell to show details of the spiral apex, D. median and representative radular teeth—radular formula 28 x 14.1.14.

The radula was slightly longer than broad when flattened (Fig. 2A). The radular formula of the specimen of body-length 34 mm was 28 × 14·1·14. The base of the median tooth (Fig. 2D) was short and wide with a main cusp and two lateral denticles. The main cusp was finely denticulated. The cusp of the laterals was similar to that of the median tooth and increased in size along the row. The outermost laterals were vestigial. A scanning electron microscope picture of an Australian specimen was given by Thompson and Bebbington (1973).

The penis was nearly as long as its sheath and was rounded at its tip. There were two retractor muscles which readily distinguishes *Aplysia parvula* from

A. punctata which has only a single retractor muscle (Bebbington and Thompson, 1968).

The posterior genital complex was similar to that described for *Aplysia punctata* (Thompson and Bebbington, 1969). The albumen gland was visible after gross dissection. Both the vesicula seminalis and the receptaculum seminis were swollen and white containing autosperms and allosperms respectively. The gametolytic gland had pinkish contents.

The cerebral ganglia were all distinct and the pleuro-visceral cords were short.

LIST OF BRITISH APLYSIOMORPHA

Order Aplysiomorpha
  Family Aplysiidae
    Sub-family Aplysiinae
      Aplysia (Pruvotaplysia) parvula Guilding in Mörch
      Aplysia (Pruvotaplysia) punctata Cuvier
      Aplysia (Varria) fasciata Poiret
      Aplysia (Aplysia) depilans (Gmelin)

KEY TO THE BRITISH APLYSIOMORPHA

1.	Parapodia joined high up posteriorly	2
	Parapodia joined low down posteriorly	*Aplysia fasciata*
2.	Foot narrow with pointed tail	3
	Foot broad, may form a posterior sucker	*Aplysia depilans*
3.	Black edges to parapodia, cephalic tentacles, rhinophores and foot. Penis with 2 retractor muscles	*Aplysia parvula*
	Without black edging to parapodia, cephalic tentacles, rhinophores and foot. Penis with single retractor muscle	*Aplysia punctata*

DISCUSSION

Aplysia punctata is the commonest British species and a full description was given by Eales (1921). *Aplysia depilans* and *Aplysia fasciata* are known from the Mediterranean and the west coast of Europe and descriptions were given by Mazzarelli (1893). Grigg (1949) gave a figure showing the differences in body outline between these three species and Bebbington and Thompson (1968) gave a table which summarized their main features. A full synonymy was given by Eales (1960).

A description of *Aplysia parvula* was given by Eales (1960). The name *Aplysia parvula* was validated by the International Commission on Zoological Nomenclature, Opinion 560, 1959 because of the doubt regarding Krauss's (1848) *Aplysia spuria*; the name *spuria* being suppressed. *Aplysia parvula* is circumtropical in distribution (Eales, 1960). It was reported by Eales (1970) from the coasts of Israel and Cyprus and assumed to have migrated into the Mediterranean

via the Red Sea. Swennen (1961) had the first record in the Mediterranean but he incorrectly identified it as *Aplysia punctata*. Bebbington (1972) reported its range extension towards Malta. Bebbington (in press) questions whether the migration is a recent one as specimens are known from Gibraltar and the Mediterranean specimens may have entered from either the western or eastern end. Because of the similarities between *Aplysia parvula* and *Aplysia punctata* it is obviously insufficient to accept body shape as a diagnostic character without further examination to determine the presence or absence of the black bordering and the number of penial retractor muscles.

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NOTE ADDED IN PROOF

Since this paper was read two further specimens of *Aplysia parvula* have been collected from near St. Keverne, Lizard peninsula, S. Cornwall: one specimen on 26 November 1974 at 'Manacles' rocks, 18 m below L.W.S.T., and the other specimen on 27 November 1974 at Porthoustock, 7·6 m below L.W.S.T. The living specimens measured 29 mm and 13 mm in length and weighed 0·22 g and 0·06 g respectively.

J. CONCH. *28* 335 (1975)

REVIEW

Sea water aquaria. By L. A. J. Jackman, F.Z.S., 176 pp., 16 black-and-white illustrations, 28 figures. David and Charles, Newton Abbot, London and Vancouver. 1974. Price £3.25.

The style of writing and content indicate that this book is directed at the enthusiastic beginner in an absorbing field of study. A great wealth of advice and information is conveyed in an informal and sometimes humorous manner.

Directions on the construction, stocking, operation and maintenance of sea water aquaria form the major part of the text. These directions, if followed, even by a novice, should lead to the successful rearing of a healthy community. It is evident that a great deal of personal experience has been condensed by the author into this book and it is gratifying to find that he, in his turn, recognises that the personal experience of would-be aquarists is of more value than printed words. Sound advice is given on how to deal with many problems, from the electrolytic action of sea water on some metals to the black, anaerobic growth which develops in thick layers of sand but only a passing reference (p. 65) is made to the problem of decaying *Fucus* spp. which will inevitably be met by anyone setting up a marine aquarium.

The extensive chapters on the collection, transport and care of animal stock in the aquarium are an essential and particularly helpful part of the book. However, the more serious student would wince at the extensive use of colloquial names for genera and species, the absence of authors after standard binominal names and the somewhat erratic manner in which the species of one genus under discussion are not completed before the species of a different genus are introduced. This unusual approach does not detract from the value of the book.

Although not specifically for conchologists, the book includes one chapter on Mollusca in the aquarium, giving advice and information on 16 "common" species:— 6 prosobranch, 3 opisthobranch, 4 lamellibranch and 3 cephalopod. However inadequate this may seem to the conchologist, one must bear in mind the purpose of this book and remember that many molluscs are difficult to keep in an aquarium, especially the algal-browsing gastropods and filter-feeding bivalves. Perhaps someone will take up the challenge on p. 91 concerning the successful rearing of opisthobranchs in an aquarium. Yet we would all agree that the advice, on p. 149, regarding the bleaching and varnishing of empty shells, needs revoking.

Many of the figures of marine animals leave something to be desired whereas the plates, although not always an essential part of the book, can do nothing but stimulate enthusiasm for setting up a marine aquarium.

This book, in spite of any fault from a nomenclatural point of view, partly fills a very large gap in marine biology with a hard core of sound, practical and enthusiastic advice and would be an essential item for anyone contemplating the idea of a sea water aquarium.

L. D. HARFIELD

Mollusks

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NOTICE

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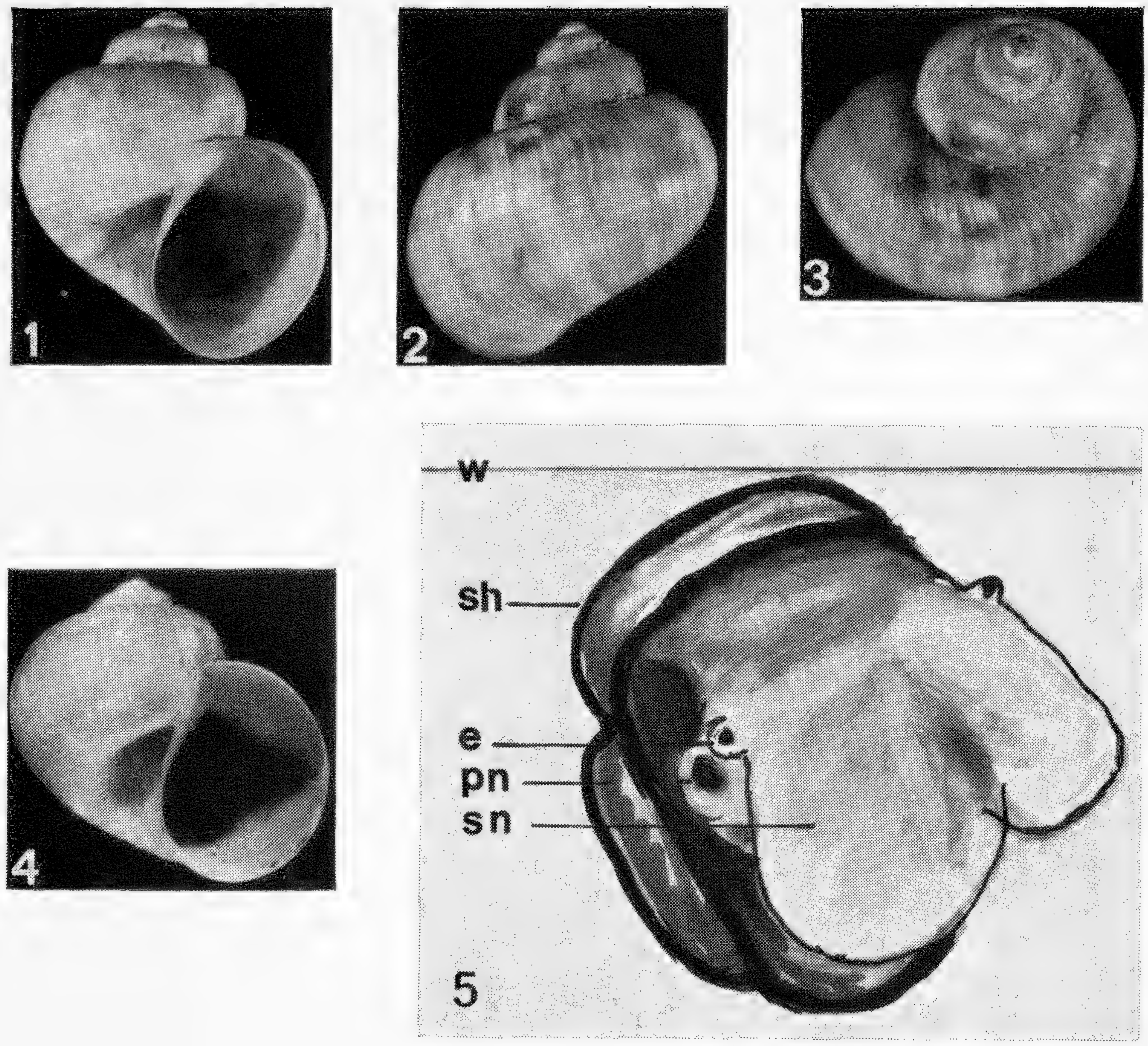
Overseas members are reminded that all monies due to the Society are payable in sterling.

Plate IX



Salinator fragilis (Lamarck, 1822)

Figs. 1–3. Lectotype, Musée d'Histoire Naturelle Geneva, No. 1094/1A ×2.

Fig. 4. Paralectotype, Musée d'Histoire Naturelle Geneva, No. 1094/1B. ×2.

Fig. 5. *S. fragilis* floating. Drawn from a photograph of a live specimen which measured 18 by 18 mm. The darker patch in the centre of the snout (sn) is the mouth seen through the semi-transparent animal; the foot and operculum are beneath this. e eye; pn pneumostone (opening of the mantle cavity); sh shell; w water level.

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ON THE OCCURRENCE OF *SALINATOR FRAGILIS* (LAMARCK) IN THE ARABIAN GULF

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(*Read before the Society, 19 October 1974*)

INTRODUCTION

In May, 1972, live specimens of a gastropod, collected by Major M. D. Gallagher in Khor Hulaylah, Arabian Gulf, were received and eventually determined as *Salinator* sp. The nearest record of this operculate pulmonate was *S. burmana* (Blandford 1867) described from the Irrawaddy and also recorded from Bombay and Malacca. Shells of specimens from the Arabian Gulf were compared with Blanford's type in the British Museum, Natural History, and appeared to be identical. However they also appeared to be identical with shells of *S. fragilis* (Lamarck 1822) from Tasmania, in my collection and that of the late Revd. H. E. J. Biggs.

THE SPECIES OF *SALINATOR*

Hubendick (1945) listed as valid species or varieties the following: *Salinator fragilis, S. fragilis* var. *quoyana* (Potiez and Michaud 1838), *S. fragilis* var. *solida* (Martens, in Schacko 1878), *S. maculata* (Mousson 1865), *S. burmana, S. sanchezi* (Quadras and Möllendorf 1895), *S. takii* Kuroda 1928 and *S. swatowensis* Yen 1939.

Ampullacera maculata does not appear to be a member of the Amphibolidae. *Salinator swatowensis* has a rounded, pyriform shell: type locality Swatow, China. *S. takii* is distinguished by the shape of the shell and the heavy flange at the base of the operculum: type locality Ariake Sea, Japan. *S. sanchezi* appears to differ from *S. fragilis* in having a chestnut band round the umbilical area and is recorded from Mindanao, Philippines. It has a larger variety, var. *spurca* Yen, from Hainan Island off the coast of China.

S. fragilis has a thin, inflated, globose shell, finely and flexuously striate, unicoloured pale horn to brown or banded with brown; aperture large, lip thin, suture deep. The operculum is very thin, horny, paucispiral, with no thickening of the rim, and no flange nor projection (Woolacott 1945). The radula has fine long slender teeth (Schacko 1878). The animal has a very square foot; it is semi-transluscent and unicoloured white to cream with a bilobed snout and black eyes set far apart on short pedicels (personal observation and personal communication from Dr. Fretter, who has collected live specimens in Queensland). It lives in swamps where some freshwater is present (Woolacott 1945).

Cotton and Godfrey (1932) suggested that *S. quoyana* may be a variety of *S. fragilis* and Woolacott (1945) considered it synonymous. *S. solida* has a stronger and thicker shell than *S. fragilis,* with conical globose shape, slightly angulated whorls, greyish cream colour with longitudinal bands of broken rust-coloured markings, smaller aperture with lip thickening towards the base, less pronounced suture, thicker and stronger operculum with an inner flange terminating in a hooked projection. The radula has coarser stronger teeth (Schacko 1878). The animal lives in a wide variety of habitats, sometimes occurring with *S. fragilis,* from mangrove swamps to brackish or almost freshwater environments (Woolacott 1945). *S. solida* was illustrated and described by Quoy and Gaimard (1832) as *Ampullacera fragilis.* The operculum with its 'onglet recourbé' and the very pretty shell with its flame-like dashes establish this as *S. solida.* The animal is described and illustrated as having a longer, rectangular foot, yellow below, and with a brownish-fawn snout marked and edged with bands of brown, the eyes being encircled with brown (Quoy and Gaimard 1832, pl. 15, figs. 10–11, 14–16). The authors relegate the true *S. fragilis* (fig. 13) to a plain variety.

S. burmana: the shell and operculum of this species agree with those of *S. fragilis* and the main reason that Blanford gave for creating a new species was that the animal "differs considerably from the figure of *Amp. fragilis* as copied from Quoy and Gaimard by both Adams and Mrs. Gray". I have not traced the drawing by Mrs. Gray but that of Adams (Adams and Adams 1855, vol. 2, pl. 84, fig. 9a) is a copy of the figure of *S. solida* (Quoy and Gaimard, 1832, pl. 15, fig. 14) extended and crawling. Blanford's description of his animal agrees with that of *S. fragilis.*

As my specimens from the Arabian Gulf agree in all respects, including the radula, with the known characters of *S. fragilis,* I have no hesitation in assigning them to this species and it appears that *S. burmana* should be in the synonymy which is as follows:

1822 *Ampullaria fragilis* Lamarck: 179.
1832 *Ampullacera fragilis* (Lamarck), Quoy and Gaimard: 196, pl. 15, fig. 13 (non figs. 10–11, 14–16 = *S. solida*).
1867 *Amphibola burmana* Blanford: 66, pl. 13, figs. 7–10.
1878 *Amphibola fragilis* (Lamarck), Schacko: 1, pl. 1, fig. 2.
1894 *Amphibola nux avellana* (Chemnitz), Pelseneer: 78, figs. 213–220.
1932 *Salinator fragilis* (Lamarck), Cotton and Godfrey: 151, pl. 3, fig. 7.
1945 *Salinator fragilis* (Lamarck), Hubendick: 103, figs. 1, 3, 5.
1945 *Salinator fragilis* (Lamarck), Woolacott: 35, pl. 3, figs. 3–6, 10.

DISTRIBUTION

S. fragilis has until now been recorded only from New South Wales, Queensland, South Australia, Western Australia and Tasmania (Woolacott 1945). It is now suggested that it also occurs, or has occurred in the past, throughout the Indonesian islands to Burma and around the coasts of India into the Arabian Gulf.

At present records in the Gulf itself are limited. *S. fragilis* does not seem to occur in Bahrain Island nor the vicinity of Kuwait (personal searches) and has not been found around Abu Dhabi (Biggs 1973 and searches by myself and other members of the Conchological Society) nor has it been recorded from Saudi Arabia (Biggs and Grantier 1960 and personal communication from Mrs. Lorraine Johansen). Long dead and sub-fossil shells have been found in various creeks between Khor Hulaylah and Ras al Ghanadha along the eastern coast of what was, until December 1971, the Trucial Coast, but it seems that the colonies that once lived in them are now extinct. Living colonies have been found in Khor Hulaylah, Hamriyah Creek and Khor Zawrah. In the first locality fresh water, containing *Melanoides tuberculata* (Müller), can be seen bubbling up in springs and *Salinator* is to be found in salinities of 41–44°/oo, which is unusually low for tidal creeks in this area. In the other localities seepage of fresh water is not conspicuous but the salinity figures are similar and aquifers probably occur there also, as they do in many areas along this coast.

LAMARCK'S SPECIMENS OF *SALINATOR FRAGILIS*

Lamarck's two specimens of *S. fragilis* are in the Musée d'Histoire Naturelle, Geneva and Prof. E. Binder has asked me to designate a lectotype. I have selected No. 1094/1A (plate IX, figs. 1–3), as it resembles the majority of my specimens in having a slightly higher spire than No. 1094/1B (plate IX, fig. 4). Photographs courtesy of the Musée d'Histoire Naturelle, Geneva.

ACKNOWLEDGEMENTS

I am most grateful to Major M. D. Gallagher for his many searches for these molluscs and for taking me to the various somewhat inaccessible localities in which he found them. I also thank most sincerely Dr. V. Fretter and Professor A. Graham for their help and encouragement in identifying this species and in the preparation of this paper; Dr. Fretter for supplying personally collected specimens of *Salinator fragilis* from Queensland for study; Dr. J. E. Chatfield for comparing radulae of specimens from Queensland and the Arabian Gulf and for the loan of Amphibolidae from the collections of the National Museum of Wales; members of the staff of the British Museum (Natural History) for much valuable help; Professor E. Binder, Dr. W. F. Ponder, Mr. P. Colman and Mr. B. Métivier for information and advice.

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SALINATOR FRAGILIS (LAMARCK) – HABITAT AND BEHAVIOUR

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(*Read before the Society, 19 October 1974*)

As I have found little in literature on the living habits of this mollusc, some observations are probably worth putting on record.

HABITAT

During 1972 and 1973 *Salinator fragilis* (Lamarck 1822) was found alive in three localities in Khors (creeks) along the eastern coast of the United Arab Emirates, Arabian Gulf. The principal habitat was on fine silty black mud below a narrow belt of the mangrove *Avicennia marina* Førsskäl, which stretches discontinuously for 7 km along the landward boundary of the tidal creek, Khor Hulaylah, north of Rams. The molluscs were somewhat patchy in distribution, but occurred from the highwater mark, where they were numerous, out for about 30 metres, where they were very scarce. At high tide, when the depth of water was about 31 cm, and at low tide they were observed in wet mud, usually submerged below the surface but sometimes with the shell visible as the animal ploughed through the mud. Traces of fine algal growth were present on the surface. The tidal range in this area is about 130 cm.

The salinity of the seawater in this vicinity at or near low tide on May 12 1973, was 44°/oo; at nearly high tide on Dec. 12, 1972, it was 41·8°/oo. This unusually low salinity for a tidal creek in the area is caused by seepage from aquifers, which collect rainwater and dew from the mountains of the Trucial Oman; at this point about 1 km from the tide line. In places strong fresh water springs can be seen. *S. fragilis* was also found alive but uncommon in one locality in Hamriyah creek and another in Khor Zawrah. Here the mud and salinity were similar but mangrove was present only at the first place and as a vestigial growth. Seepage of fresh water probably occurs at both these spots, as the salinity is low for these types of creeks, but the mountains are over 40 km away and springs were not visible. Woolacott (1945) observed that *S. fragilis* is only found where some fresh water is present.

BEHAVIOUR IN CAPTIVITY

In 1972 I kept successive batches of live *S. fragilis* in a marine aquarium stocked with local seawater from Pagham Harbour (salinity 23°/oo) and *Entero-*

morpha spp. Initially they climbed among the algae, but as the walls of the aquarium became established with, presumably, more attractive food, they crawled frequently and fairly actively around them, the movement of the radula being evident as they grazed. Some of them remained under water for long periods, occasionally emitting bubbles of air from the lung: some spent various periods out of water: some floated periodically to the surface of the water and hung there (plate IX, fig. 5). They also displayed an ability to float at varying depths and to adjust the depth either slowly or rapidly. I observed one animal which, after looking round for some minutes, appeared quite deliberately to float up to a particular piece of algae. Observations in the field on this aspect of behaviour proved impracticable. The survival rate in these conditions was about three weeks.

The last batch brought to England in October 1972, was kept in a jar with 3 cm of seawater, stocked with *Enteromorpha* and placed over a radiator in a room with an average temperature of 20°C. This batch survived for just over 8 weeks. Even in this limited depth of water they floated periodically. Some were placed in a receptacle with mud from Pagham Harbour and seawater, but this appeared to be unacceptable—probably because the particle size and heavy quality of the mud was unsuitable. The animals abandoned the mud as quickly as possible.

In May 1973 I brought back specimens, mud and seawater from Khor Hulaylah. These I kept in a glass container shallowly and irregularly filled with mud to about 6 mm and covered by seawater to a depth of 6–12 mm. The container was covered by glass and topped up to maintain the depth with distilled water. Some of these were still alive at the end of September 1974. Mud of appropriate particle size and organic content appears essential for these molluscs; it is consumed continuously. Quoy and Gaimard (1832) illustrate *S. solida* (Martens in Schacko 1878) and show a somewhat puzzling threadlike corkscrew process emanating from the edge of the aperture. Examination of living *Salinator* shows that this is the trail of mud exuded as the animal crawls.

In all conditions in which I kept *Salinator* they showed a marked preference for sunlight, keeping consistently to the brightest side of the container. On sunny days they are very active but on dull days they become sluggish.

In August 1972 I noticed a minute mass of jelly with a bright surface on the aquarium wall and managed to extract and isolate it. Under the microscope it could be seen to be a miniature *Salinator* with three bands of brown round a semi-translucent shell. It survived for six weeks, during which it grew to 3 mm in diameter. A similar sized specimen which I brought back with me in 1973 also survived for six weeks and grew to the same size.

REPRODUCTION

Farnie (1924) investigated the development of the eggs of the allied species *Amphibola crenata* (Gmelin) and described a veliger stage within the egg, the animal hatching as a crawling miniature adult. Fraeme (1940) said that the eggs of *S. fragilis* take 14 to 16 days to hatch and, though not commented on in the

text, a photograph entitled 'Ciliated embryos' shows embryo veligers within the egg capsule. The implication of this article would be that the embryos hatch crawling, though nothing is stated about the hatching. Tanaka (1959) described the development of the eggs of *S. takii* Kuroda. The text is in Japanese but the illustrations are captioned in English and the resumé is in English. One illustration shows a free-swimming veliger larva.

On 7 November 1972, I observed two specimens of *Salinator* encircling each other in close contact for about ten minutes. On 9 November both laid eggs loose on the *Enteromorpha* in the jar. These I took to Reading but the eggs disintegrated after developing for several days (personal communication from Dr. Fretter). In September 1973 Mrs. V. Gallagher brought back more mud, water and specimens of *Salinator* from Khor Hulaylah. On 24 September two of these were crawling round each other in close contact: on 26 September I found two egg masses. These swelled somewhat within 24 hours to measurements of 5·5 mm × 2·75 mm and 7 mm × 3 mm respectively. They seemed jelly-like and were cemented all round by mud.

Fraeme stated that *Salinator* lays eggs in a ring-shaped mass. My specimens laid eggs in an elongated mass. No ring-shaped masses were found in Khor Hulaylah though they were searched for. This difference may be due to environmental factors, or perhaps Fraeme's specimens may have been *S. solida* which may have different egg-laying habits: her research was carried out before Woolacott demonstrated that there were two species of *Salinator* in Australia. On 12 October, 17 days after being deposited, one of my egg masses burst open at the centre and veligers began to swim rapidly to the surface of the water. Fortunately I was looking at it under the microscope at this precise moment; possibly the heat of the lamp sparked off the imminent hatching. Mr. M. Goodchild was also able to observe the hatching. I took these veligers to Dr. Fretter in Reading. She informed me that they lived for three days which was good considering that they had been hatched in totally alien conditions far from their native plankton.

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I must express my gratitude to Major M. D. Gallagher for collecting so many batches of specimens for me and to Mrs. Gallagher for bringing back specimens. I also thank Dr. V. Fretter and Professor A. Graham for their encouragement and help; my hosts in Sharjah: Lt. Col. and Mrs. D. Carson and Mr. and Mrs. J. Taeger, for their hospitality which enabled me to make my own observations in the field; Dr. P. Russell and Mr. M. Farnham and the staff of the Marine Biological Laboratory at Hayling Island for caring for the first live specimens while I made preparations for their accommodation.

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A REVIEW OF THE PREDATORS OF *LITTORINA*, ESPECIALLY THOSE OF *L. SAXATILIS* (OLIVI) [GASTROPODA: PROSOBRANCHIA]

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(*Read before the Society, 16 November 1974*)

INTRODUCTION

During studies on the distribution of the colour morphs of *Littorina saxatilis* (Olivi, 1792) evidence was found that visual selection must be considered as a factor governing this distribution (Pettitt, 1973); further evidence has since been adduced by Heller (1975a). The literature was therefore searched to discover what animals might be causing the selection pressure. References to littorines as prey organisms are scattered widely through the zoological literature; often the food organisms of predators are not precisely identified and published data then require careful interpretation. Hartley (1949) gives a good review of the problems caused by the differing presentation used by various authors for data on the food of birds.

In a recent paper Heller (1975b) claims that in Britain what is commonly regarded as *L. saxatilis* is composed of four species, *L. nigrolineata* Gray, *L. rudis* Maton, *L. neglecta* Bean and *L. patula* Thorpe. The papers reviewed here do not distinguish between Heller's species, so that reference to '*L. saxatilis*' should be interpreted as 'one member at least of the *L. saxatilis* species complex'. Sometimes subspecies or varieties are referred to, but even here caution is needed as, for example, *rudis auctt.* may not necessarily conform precisely to *rudis* as defined by Heller.

As the four species occupy separate ecological niches it is probable that they suffer different pressures from the various predators, although this has not yet been investigated. It is perhaps worth pointing out that even though a predator's food selection may only contain a small percentage of littorines, it may still be the most important selective agent acting on a particular population of snails, if that population is one of low-density; even in a high-density population it may be the most important selective agent if it has colour-vision and the other predators do not. This implies that one cannot dismiss on quantitative grounds a particular species of predator as an unimportant agent in the maintenance of colour polymorphism in the snails.

The known or probable predators of littorines include birds, crustacea, molluscs,

fish and mammals. In this account the evidence for each group is given in turn and is followed, where relevant, by information on colour vision, visual acuity and hunting behaviour, all of which may affect the amount of visual selection caused by each group.

BIRDS AS PREDATORS

The main avian predators on *L. saxatilis* in Britain are shore birds belonging to the families Haematopodidae (Oystercatchers), Charadriidae (Plovers), Scolapacidae (Snipe, Curlew, Godwits and Sandpipers), Laridae (Gulls and Terns) and the Motacillidae (Pipits and Wagtails); in addition, Sea Ducks of the family Anatidae eat winkles, though probably not *L. saxatilis.* A wide variety of land birds also have been reported feeding on the shore and are possible predators of the rough winkles.

Haematopodidae. For a long time the Oystercatcher, *Haematopus ostralegus L.,* has been known to take shelled molluscs as part of its diet (e.g. Macgillivray, 1852); the first record of it feeding on littorines was from Norway (Collett, 1872). Patten (1906) gave 'periwinkles' as part of the diet of Oystercatchers; he found in several gizzards winkle opercula up to 12 mm in diameter. A 12 mm operculum would indicate a shell 20–25 mm high; it is unlikely that an Oystercatcher could swallow shells of this size, so the opercula are probably from snails which have been pecked out of their shells. The normal size of mussels attacked by Oystercatchers in the Firth of Forth is 3 to 4 cm long by 1·2 to 2 cm wide (Dewar, 1908); the birds appear to be size selective, rarely taking shells larger than 4·5 × 2·3 cm and only those mussels smaller than 2·5 × 1·1 cm when the preferred larger animals are not available. This evidence supports the supposition that larger winkles are removed from their shells before ingestion.

I could find no information on how Oystercatchers might remove large winkles from their shells, but they presumably do it in the same way that they open the dog-whelk, *Nucella lapillus* (L.). They feed on these by carrying the shells to a crack in a rock or to a bed of firm sand; they apparently need room to work. The birds first attack the aperture and push out a disc-shaped piece of the underside of the shell, on the body whorl. The shell is then turned over, the bill inserted and a semi-lune of the lip broken away; the mollusc is then extracted from its shell. This behaviour is time consuming, and Oystercatchers only feed on *Nucella* in this fashion locally and irregularly (Dewar, 1910).

Oystercatchers taking *L. saxatilis* in Wales normally selected the thinner-shelled form which James (1968a) called 'subspecies *tenebrosa*'. When their normal food, Patellidae, was greatly depleted by cold in the winter of 1962—63, they tried to utilize as food the thicker-shelled snails which James called 'subspecies *rudis* and *jugosa*', but they were unable to crush them in the gizzard and they passed undigested through the gut.

Dare (1966), after a detailed study of the prey of Oystercatchers, concludes that *Littorina* spp. are only an occasional food in Britain, normally of little

importance; he did find, however, nearly 200 littorine opercula in the stomach of a bird in Wales. In a later paper (Dare and Mercer, 1973) evidence is given that in Morecambe Bay, Lancashire, some individual birds tend to specialize on particular prey organisms. These authors found that of 1,247 birds from the Heysham/Roosebeck mussel-beds (or 'skears'), 10 specialized in winkles, one having more than 60 opercula in its gizzard; among 283 birds examined from the Levan estuary (mixed sandflats and mussel-skears), they found 12 littorine feeders, one with about 90 opercula in its gizzard.

Charadriidae. The Turnstone, *Arenaria interpres* (L.), has been seen in Cornwall taking *L. neritoides* (L.) of 3 to 4 mm shell-length (Gibb, 1956); it may well have been taking also *L. neglecta* and the juveniles of other rough winkles. Davidson (1971) found 12 Turnstones in Morecambe Bay to contain a total of 16 specimens of *Littorina* spp. The Ringed Plover, *Charadrius hiaticula* L., has been found by Lebour (1912) to contain the adult stage of the trematode parasite *Microphallus pygmaeus* (Levinsen, 1881), the larval form of which is found in *L. saxatilis* 'subspecies *tenebrosa*' (James, 1968b). As this parasite has no free-living stage and only the one intermediate host, this evidence points to the Ringed Plover as a predator of the rough winkle.

Scolapacidae. Swinhoe (1863) noted that the gizzards of Dunlins, *Calidris alpina* (L.), in Formosa were packed with small gastropod shells during cold weather. Dewar (1909) observed Dunlins feeding on 'small periwinkles' in empty barnacle shells; these may well have been *L. neritoides* or *L. neglecta.* The birds only showed this behaviour when the molluscs were present in sufficient numbers to make it worth their while; only small shells 3–5 mm long were taken. Dewar also noted Dunlins preying on small snails on mudflats if the population was sufficiently dense, and Ehlert (1964) studying the Dunlin on sandy mud at Bird I., Mellum, found *L. littorea* (L.) constituted 6·6% of its diet; these latter findings are not relevant to *L. saxatilis,* however, as it does not occur on muddy substrates. Holmes (1966) did not find Dunlins took *Littorina* in Alaska.

Gibb (1956) working mainly in Cornwall, with visits to Argyll and to Co. Cork, and Feare (1967) at Robin Hood's Bay, Yorkshire, found the Purple Sandpiper, *Calidris maritima* Brünnich, taking littorines with shells 2–5 mm long, occasionally up to 8 mm shell length. *L. saxatilis* is the main prey of this bird when overwintering in the Bay of Fundy, Nova Scotia (Austin-Smith, 1968). The birds searched both crevices and rockpools for the snails, which they swallowed whole and ground to fragments in the gizzard; a few fragments of *L. littoralis* shells were found in the gizzard, but none of *L. littorea* (Smith and Bleakney, 1969). Hartley and Fischer (1936) found no littorines in Purple Sandpipers examined at Spitzbergen.

Several other members of this family are known or possible predators of *L. saxatilis.* The Curlew, *Numenius arquata* (L), as well as the Dunlin, has been seen taking *L. saxatilis* 'subspecies *tenebrosa*' in Wales (James, 1964). Ehlert (1964), besides summarising other authors, gives the food of the Knot, *Calidris canutus* (L.), as including 25% *L. littorea.* The diet of both the Common Sand-

piper, *Tringa hypoleucos* L., and the Redshank, *T. totanus* (L.), in Britain included 15% of unspecified molluscs (Collinge, 1924–7); Blezard (1967) reports the latter species taking *L. saxatilis* in Solway. In the Ythan Estuary, Aberdeenshire, *Littorina* spp. were only found in the gizzard of the Redshank in cold weather; the mean numbers present per bird being 1·7 at temperatures less than 4°C., and 0·3 at temperatures between 4° and 8°C. In this locality the birds hunt at night, by pushing their beaks through the mud to catch *Hydrobia* sp.; it is quite possible that they take littorines by this method also (Goss-Custard, 1969).

Laridae. Herring gulls, *Larus argentatus* Pontoppidan, have been recorded taking *Nucella lapillus, L. saxatilis, L. littorea* and *L. littoralis* on the coast of Maine, U.S.A. (Colton, 1916). Molluscs have been found to constitute some 5% of the Herring gull's diet in Britain (Collinge, 1924–7); in the Plymouth area Herring gulls have at times been seen feeding entirely on molluscs (Moore, 1938). Unspecified molluscs have been reported as forming 41% of the food in 515 Herring gull stomachs examined in the Barents Sea area (Belopolskii, 1957). James saw the Herring gull taking *L. saxatilis* 'subspecies *tenebrosa*' at Twr Gwylanod, Wales (James, 1964). At the same locality the Herring gull has been found to contain the adult of the large form of the trematode parasite *Microphallus pygmaeus*; the larval stages of this form are only found in large, thin-shelled, sexually-spent adult *L. saxatilis* 'subspecies *tenebrosa*' (with a shell length greater than 10 mm); there is no free-living stage or second intermediate host in this species of *Microphallus.* The small form of the parasite whose larvae are only found in juvenile *L. saxatilis 'tenebrosa',* is absent from the Herring gull, possibly because the small, 3 to 4 mm long shells do not represent an efficient food for such a large bird. The adult of the small form of the parasite is found in smaller birds, such as the Rock Pipit (q.v.), which could not swallow the adult snails (James, 1964, 1968a, b). A similar parasite, *Microphallus similis* (Jäg.), has its asexual stages in the littorines *L. saxatilis, L. littorea* and *L. littoralis,* but it cannot be used as evidence of the predation on snails as it passes to the Herring gull and to the Common Tern, *Sterna hirundo* L., via a second intermediate host, the crab *Carcinus maenas* (Stunkard, 1957).

A good summary of the literature on the feeding habits of the Herring gull, the Lesser Blackbacked gull, *Larus fuscus* L., and the Greater Blackbacked gull, *L. marinus* L. is given by Harris (1965). He did not find any littorines taken by these birds at Skomer and Skokholm, but as both these localities are very exposed there may not have been many winkles available. Belopolskii (1957) found molluscs to comprise 29% of the food of *L. marinus* in the Barents Sea; Collinge (1924–27) records 2 to 30% of molluscs in the diet of this bird in Britain, 5 to 23·5% in that of the Lesser Blackbacked gull, 3·2 to 14·2% in the Blackheaded gull *L. ridibundus* L., 3 to 25·7% in the Common Tern, 1·5 to 27% in the Common gull, *L. canus* L., and 5 to 55% in the Kittiwake, *Rissa tridactyla* (L.). The figures quoted from the last author are the lowest and highest percentages recorded throughout the year; the higher figures were recorded in winter. Franck

(1965) gives details of the feeding behaviour of the Herring and Common gulls, but no information on the food taken.

Motacillidae. The food of the Rock Pipit, *Anthus spinoletta* (L.), was studied in detail by Gibb (1956) in Cornwall over five years, mainly in the winter; he also made some observations in Argyll and in Co. Cork, Eire. The main reserve food was given as *L. neritoides*, but it is probable that small *L. neglecta* were also taken. The snail population was dense, 25,000 per square metre being counted. The birds picked up the snails singly and ate them whole; the average number taken per minute was about 32 (standard deviation: 12). By comparing the size of the opercula found in the faeces with that of the live snails it was found that the Rock Pipit tended to select shells 2·5 to 3·0 mm in length. Rock Pipits have been noted feeding avidly on *L. saxatilis* 'subspecies *tenebrosa*' at Twr Gwylanod, Wales (James, 1964). As mentioned above, James (1968b) found the snail form of the trematode *Microphallus pygmaeus* to cycle from juvenile *L. saxatilis 'tenebrosa'* of shell length 2 to 3 mm to Rock Pipits and back to *saxatilis,* presumably via the birds' faeces; this information agrees with the sizes of shell noted by Gibb as being taken most frequently by the Rock Pipit.

Anatidae. A sample of shells taken from the oesophagus of an Eider duck was found in the Manchester Museum collection; this was presumably the Common Eider, *Somateria mollissima* (L.). There are 326 unbroken shells of *Lacuna vincta* (Mont.) and 18 unbroken shells of *Patina pellucida* (L.), plus some fragments, in the sample. The *Lacuna* ranged from 2·9 to 7·0 mm in length; of the *Patina,* all roughly equal in size, the largest measures 10·2 mm long, 7·9 mm wide and 3·8 mm high. Gorman and Milne (1972) found the Common Eider preying on littorines on the Sands of Forvie, Scotland, where the chicks took small gastropods from the mudflats; the adult Eiders fed elsewhere. Eiders obtain their food by diving, finding most of it at depths of 3–7 m., and molluscs constitute just over 50% of their diet; the rest is mainly echinoderms, coelenterates and insects, with seaweed forming only 5% of the total (Bannerman and Lodge, 1958). Pertsov and Flint (1963) estimated consumption by Eiders in the Kandalaksha Reserve, White Sea area, at about 15% of *Littorina* stocks, or some 95 metric tons of winkles a year. Cantin *et al.* (1974) examined 162 adult and 245 juvenile Common Eiders in the St. Lawrence Estuary and found 72 adults and 116 juveniles contained *L. saxatilis*; the corresponding figures for *L. obtusata* were 61 and 113, and for *Lacuna vincta* 10 and 18, while 107 adults and 234 juveniles contained unidentifiable winkles. Studying sea-ducks on the New Hampshire coast, Stott and Olson (1973) found 40% of Oldsquaws (*Clangula hymenalis*) to contain *Lacuna vincta,* and 13% contained *L. littorea.* The latter species occurred in 55% of the Buffleheads (*Bucephala albeola*) examined, with *L. obtusata* in 16% and *Lacuna vincta* in less than 1% of the birds. Finally they found 44% of Goldeneyes (*Bucephala clangula*) to contain *Lacuna vincta* but *L. littorea* and *L. obtusata* occurred in less than 1% of these birds. Bartonek and Murdy (1970) found littorines in the oesophageal contents of the lesser Scaup (*Aythya affinis*) in Yellowknife, N.W. Territories, Canada. All this evidence indicates that sea-

ducks are not herbivorous browsers but either selective omnivores or carnivores; as they feed only on the lower shore they are unlikely to be important predators of *L. saxatilis.*

Land Birds. Foster and Gibb (1950) record 14 spp. of land birds which were seen feeding on the shore at Loch Sunart, Scotland, including such unusual 'shore' birds as the Swallow, *Hirundo rustica* L., and the Chaffinch, *Fringilla coelebs* L. Loch Sunart is, however, an unusual bit of shore, being a very protected, probably hyposaline sealoch (Dr. L. M. Cook, pers. comm.). Venables (1936) noted Song thrushes, *Turdus ericetorum* Turton, feeding on *Nucella lapillus* during a hard frost; most of the observations of land birds feeding on the shore have been made during cold weather. A later note by Hunt and Stevens (1964) about the Song thrush feeding on periwinkles prompted a number of replies; these were collated and published by Feare (1967). The feeding behaviour noted by Hunt and Stevens does not seem uncommon and is not restricted to Song thrushes as predators or periwinkles as prey. The records cover the Outer Hebrides, Sutherland, Ross, Cromarty, Anglesey, Pembroke, Lancashire, Cheshire, Cornwall and Dorset. Feare reports that at Robin Hood's Bay he frequently saw Lapwings, *Vanellus vanellus* (L.), Robins, *Erithacus rubecula* (L.), Meadow pipits, *Anthus pratensis* (L.) and Starlings, *Sturnus vulgaris* L., feeding in the upper littoral zone, and Vader (1970) quotes *L. littorea* as a prey of Starlings. M. P. Harris (quoted in Feare, 1967) found *L. saxatilis* in the stomachs of Redwings, *Turdus musicus* L., Blackbirds, *T. merula* L. and Mistle Thrushes, *T. viscivorous* L.

As when taking land snails, *Turdus* tends to use an anvil to open winkles; they break the side of the shell open, whereas crabs, such as *Carcinus maenas* (L.) (q.v.) break off the top of the shell. Feare (1967) includes pictures of shells broken by thrushes and by crabs. The taking of marine gastropods, in particular *Nucella* and *Littorina,* by a number of land and sea birds seems to be as an alternative or reserve food. During the cold winter of 1962–63, 90 spp. of birds were seen, in Britain, taking food thought to be unusual (Dobinson and Richards, 1964). It is interesting that *L. saxatilis, L. littorea, L. littoralis* and *Nucella lapillus* all appear to have been relatively unaffected by that winter (Crisp, *et al,* 1964).

The Dipper, *Cinclus cinclus* (L.), was seen probably taking *L. saxatilis* in the mesohaline Esefjord in West Norway. The birds ignored the numerous winkles in the intertidal zone and only fed on those permanently submerged in the shallow fjord (Vader, 1971).

COLOUR VISION AND VISUAL ACUITY IN BIRDS

Colour vision in birds has been known and investigated for many years; Wojtusiak (1964) and Peiponen (1966) contain good reviews of colour vision theories. Adler (1963) concluded that colour sensitivity of birds was much the same as in humans; birds detect the blue end of the spectrum better than a normal human eye. Birds tend to prefer colours found in their own plumage (Dücker, 1963). Avian eyes have rapid accommodation (Malone, 1965); Kare

(in Sturkie, 1965) concludes that the rate of assimilation of visual detail is much greater in birds than in mammals, and also concludes that all diurnal birds have colour vision, probably seeing red, yellow and orange best.

Visual selection of colour morphs of land snails by birds (indicating good colour vision) was established in the classic paper of Cain and Sheppard (1950). That similar selection takes place on the shore would seem probable, but evidence for it tends to be inferential, from associations of shell colours and patterns with backgrounds upon which they are cryptic (Pettitt, 1973; Heller, 1975a). The necessity for inferential reasoning stems from the remarkable fact that very few empty littorine shells are to be found on the beach (Linke, 1933; Deyglun, 1955 and personal observation), in contrast to the semi-permanent record left by, say, a thrush round its anvil. The record of littoral predation is largely removed or destroyed by wave action every tide.

CRUSTACEA AS PREDATORS

Crabs. The common shore crab, *Carcinus maenas* (L.), one of the main predators on *Nucella lapillus,* shows a strong preference for the thin-shelled forms of the snail (Ebling *et al*, 1964; Kitching *et al,* 1965; Feare, 1967). *Littorina* species are the second most dominant food of *C. maenas* at Gareloch, Scotland, and larger specimens of *Carcinus* showed some selection of *L. littorea* (Perkins and Penfound, 1969), while Perkins (1970) states *L. saxatilis* is a normal food of *C. maenas* in Scotland. The life cycle of the trematode parasite *Microphallus similis,* mentioned above under birds, offers further evidence that *C. maenas* preys on *L. saxatilis, L. littorea* and, possibly, *L. littoralis* as well. To open shells the crabs grasp the apex with one chela and rotate the shell with the other until the apex breaks off. The Edible crab, *Cancer pagurus* L., lacks such finesse however, and to extract the meat it crushes the shells of winkles and dogwhelks completely (Feare, 1967). As might be expected, small individuals of both species of crab took only small shells, whereas the adults attacked both large and small ones. Ebling *et al.* (1964) found that *Portunus puber* (L.), the velvet crab, also preferentially attacks thin-shelled *Nucella,* sometimes by pulling the mollusc's body out of the shell; crab predation on littorines is not mentioned, but Ebling *et al* (1960) state that *L. saxatilis* occurs at all their stations round Loch Ine.

Large shells of *L. saxatilis* are occasionally inhabited by hermit crabs; until recently it was thought these crabs always inhabited empty shells and never killed the original owner. However, Binder (noted by Gardiner, 1972) reports that *Pagurus longicarpus* Say, a North American hermit crab, has an effective method of killing littorinids and taking over their shells; this was observed in an aquarium. Frontal attack using the relatively small chelipeds proved of no avail, the snail withdrawing into its shell, blocking the aperture with its operculum. Then the crab, which had been pushing the snail back into its shell while lodged against the side of the aquarium, continued to apply pressure until it was able to attach its uropod to the inner surface of the aperture of the shell. At this point, the crab had gained sufficient hold on the shell to be able to walk around with the shell

remaining in place over its soft tail. Each day the crab's body seemed to move further into the shell; it was evident that once the hermit crab could push the snail far enough back to allow it to gain a hold with its uropod, it could exert constant force on the snail. The snail obviously could not feed, and after two weeks the crab was found feeding on pieces of snail's flesh attached to the operculum. This behaviour was observed on several occasions.

Lobsters. Squires (1970) examined the stomachs of 182 lobsters in Newfoundland, and found 22% contained littorines; Miller *et al.* (1971) estimated 11% of the food of *Homarus americanus* at St. Margarets Bay, Nova Scotia, consisted of 'periwinkles', which Scarrett (in Miller *et al.* 1971) found also in 36% of lobsters taken off Prince Edward Island. Lobsters are known to move upshore with the tide and could well attack midshore populations of '*L. saxatilis*'.

Shrimps and Prawns. Crangon and *Palaemon spp.* eagerly devour small *Rissoa, Hydrobia* and, specifically, *L. saxatilis 'tenebrosa'* (Blegvad, 1914).

VISION, OLFACTION AND HUNTING BEHAVIOUR IN CRUSTACEA

Crabs have colour vision, and detect moving objects better if they contrast with their background, and best of all if the object is striped (Waterman, 1961); this may be relevant as some *saxatilis* are banded or lined.

Specific grasping and feeding reactions occur when one walking-leg of a crab touches a piece of blotting paper soaked in meat juice, the receptors involved being able to distinguish between a number of different substances (Luther, 1930). Similar receptors have been found in the wall of the gill chamber which causes a 'feeding' reaction when a piece of paper soaked in meat juice is placed close to the respiratory intake (Buddenbrock, 1945, quoted in Barber, 1961). The behaviour of *Carcinus maenas* in South Wales has been studied in detail by Crothers (1968): "Potential prey is detected at a distance through the water by sense organs on the antennae. The crab makes apparently random movements with its legs and chelae. Funnel canals on the tips of the appendages respond quickly to the touch of any food substance, and the crab jumps on its prey, pinning it to the ground". The attraction of *C. maenas* by the smell of molluscan flesh has been shown by Shelton and Mackie (1971). Another hunting method of predatory forms of crab is close examination of the ground surface (Schone, 1961); this would presumably help in finding *L. saxatilis* and other littorines among boulders or in rockpools. Evidence indicates that lobsters (*Homarus americanus* and *H. gammarus*) also hunt by smell (Mackie and Shelton, 1972; McLeese, 1973). None of these last hunting methods would cause much visual selection, but evidence recently adduced by Reimchen (1974) indicates that crabs are important agents of visual selection in *L. obtusata* and *L. mariae.*

FISH AS PREDATORS

Blegvad (1914) makes a general reference to fish such as plaice, dab, flounder,

gobies and eels, etc., eating "small snails in the plant region" in Danish waters. Specifically he records a large *L. littorea* found in the stomach of an eel. The Cunner, *Tautogolabrus adspersus* Walbaum, and the Pollack, *Pollachius virens* (L.), on the coast of Maine, U.S.A., come up at high tide to feed in areas where *L. saxatilis* might live; a few Pollack caught at high water had their stomachs full of young *L. littoralis* (Colton, 1916).

Wright (1936) considered young *L. littorea* and *L. saxatilis* were probably preyed upon in Essex by the Flounder, *Pleuronectes flesus* L. This was confirmed by Hartley (1939), who lists the food found in the stomachs of a large number of fish in Devon; the other fish which he found took *Littorina* and similar gastropods were: the Dab, *P. limanda* (L.), the Whiting, *Gadus merlangus* L., the Dragonet, *Callionymus lyra* L. and the Gobies, *Gobius* spp. Detailed evidence of Flounder predation on littorines in the Bay of Fundy, Newfoundland, is provided by Wells *et al.* (1973), who found that of 43 Flounders caught at high-tide in the intertidal zone, 3 contained a total of 38 *L. littorea,* while of 41 Flounders taken sub-littorally 1 contained 5 *L. saxatilis* and 1 contained 2 *L. littorea.* These authors conclude that the first batch of fish fed mainly on food species in the intertidal zone and the second batch partially on sublittoral and partially on intertidal food species.

Gastropods (species not given) made up between 18% and 55% of the stomach contents of Blennies, *Blennius pholis* L., examined by Quasim (1957). Molluscs, including *Littorina* spp. have been found to comprise between 1% and 4% of the food of 286 specimens of the Sea Scorpion, *Acanthocottus bubalis* (L.), examined by Rice (1962) in the Isle of Man. Previously unpublished data of P. J. Miller, quoted by Rice, indicated that *Gobius paganellus* L. had a similar diet to that of *A. bubalis.* The findings of Hosey and Coad (1970) for these three species at Roscoff agree with the previous authors; they found a 'small broken gastropod' in the Sea Scorpion, '*Patella,* barnacles and one 3 mm *L. saxatilis*' (? *L. neglecta*) in the Blenny, and *Littorina littorea* and *Nassarius incrassatus* (Ström) in the Goby. These three last mentioned fish species all move upshore with the incoming tide and could well feed in areas where *L. saxatilis* occurs, particularly populations living on boulder shores and among barnacles on rocks. One species of Blenny, *Coryphoblennius galerita* (L.), which at low water is separated from its main food of barnacles, has been seen by skin-divers, feeding on *L. saxatilis* at high water, i.e. many feet from the nearest localities which would be habitable by the fish at low water (Gibson, 1970).

Several other papers dealing with the food of fish give only negative results, i.e. many fish have not been found to feed on littorines: Davis, 1923; Steven, 1930; Eales, 1949. Most of the fish studied by these authors are unlikely to meet with littorines in the normal course of events, but the negative findings of Hosey and Coad (1970) with the Rocklings *Onos tricirratus* Brünn and *O. mustela* Risso are of interest; Wheeler (1969) noted *Littorina* spp. as an occasional food of the former.

VISION IN FISH

Teleost fish have colour vision (Yager, 1968; Protasov, 1970) and can discriminate patterns (Sutherland, 1968); they probably contribute to the visual selection of littorines, but the extent of their contribution is not assessable on the information at present available.

CARNIVOROUS MOLLUSCS AS PREDATORS

The most important molluscan predator of North Atlantic littorines appears to be *Nucella lapillus.* Colton (1916) noted *Nucella* feeding on periwinkles in Maine, U.S.A., by drilling the shell; another method of attack was observed by Dr. J. Iles (*pers. comm.*) who has seen *Nucella* feeding on *L. saxatilis* by inserting its proboscis under the operculum of the littorine. Riser (1969) found several whelks, *Colus stimpsoni* (Mörch), feeding on *L. littorea* on eelgrass beds at Edmunds, Maine. The periwinkle was enveloped by the foot of the whelk, aperture to aperture; in all observed feedings, the proboscis was inserted between the operculum and columella and all living parts of the prey were ingested.

The shells of the animals attacked in this latter fashion presumably would bear no distinguishing marks, and therefore the frequency of drilled shells cannot be used to establish the level of predation pressure, even if empty *Littorina* shells were not subject to removal by wave action, as noted earlier. Lewis (1964) noted that the sublittoral *Nucella,* normally occupying a zone below the winkles, may move upshore with the tide to attack high littoral animals.

Ankel and Christensen (1963), quoted in Cheng (1967), found the tectibranch mollusc *Odostomia scalaria* Macgillivray feeding on *L. saxatilis* in Danish waters.

VISION AND OLFACTION IN MOLLUSCS

Although littorines have well developed eyes (Newell, 1965) and may have form vision (Evans, 1961), the possession of good vision by predatory molluscs has not yet been established. There is some evidence of colour vision in molluscs (Ewers, 1967), particularly in carnivorous ones. However, if any distance tracking of prey by predatory gastropods is done it is almost certainly by means of smell. That smell is probably of importance to at least one carnivorous mollusc is indicated by the vivid description given in Raeihle (1969) of *Busycon spiratum* (Lam.) attacking *L. saxatilis* and other littorines in an aquarium: 'When *L. saxatilis* . . . (is) dropped into the aquarium it is very few seconds before the *Busycon* fairly explodes out of the sand, tentacles and siphon waving, frequently proboscis also, to track down and attack the Littorinidae.' These observations, of course, are of captive specimens; in their natural habitats *Busycon* and *L. saxatilis* have different ecological stations.

Prosobranch gastropods tend to follow the mucous trails of their own species (Dimon, 1905; Schafer, 1950; Gibson, 1964; Struhsaker, 1966; Wells and Buckley, 1972 and personal observation). Peters (1964) noted that snails lacking tentacles did not follow such trails, indicating that the response is a chemosensory

one and not simply tactile. Examples of marine carnivorous molluscs hunting other gastropods by selectively following the mucous trail of the prey have been reported by Gonor (1965) and by Paine (1963).

MAMMALS AS PREDATORS

Collinge (1924–27) has noted that rats and other small mammals feed fairly frequently on the seashore, where they probably take snails much as they do on land. The major molluscan gastropod prey of man on the seashore is the edible winkle, *L. littorea,* of which large quantities have been consumed in Britain over the last 150 years or so (Wright, 1936; Zinn, 1964). Winkles are also eaten in Eire, China, Japan and the U.S.A. '*L. saxatilis*' are largely spared the predations of man, mainly because the ovoviviparous reproductive mode of all but *L. nigrolineata* causes the presence of unpalatable shelled spat in the females; these lead, as Clark (1850) so graphically put it, to a 'grittiness arising from the craunching of the testaceous pulli'. However, as Murie (1903) noted, the larger specimens of the rough winkle are occasionally collected by winklers, who also tend to destroy large quantities of both *L. littorea* and *L. saxatilis* by treading the smaller specimens into the mud, where they suffocate.

Clay (1961) points out that *L. saxatilis* and *L. littoralis* are used by man for decorative purposes; but only a very small quantity of these snails are used commercially in this way. However, from personal observation, the predation pressure of small boys and girls on the more brightly coloured morphs cannot be ignored. Finally, the late Miss E. Jones informed me that on the shore her Setter dog used to take, crush and avidly eat 'winkles'.

SUMMARY

There is considerable evidence of predation on littorines by members of a number of groups of animals. The most widespread and numerous predators, both in number of species and in absolute numbers, are found among the seabirds and littoral crustaceans. The evidence also indicates that these two groups are likely to cause the bulk of any visual selection of the colour morphs of *L. saxatilis* (Olivi).

Fish, predatory molluscs and mammals also exert a considerable predation pressure on the snails, but from the information so far assembled it does not seem likely that they contribute much to any visual selection of their prey populations.

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TABLE 1

SUMMARY OF THE KNOWN PREDATORS OF LITTORINA

Predator	*L. saxatilis*	*L. neritoides*	*L. littoralis*	*L. littorea*	*Littorina spp.*
BIRDS					
Anthus spinoletta (L.) (Rock Pipit)	×	×			
Arenaria interpres (L.) (Turnstone)	(×)	×			×
Calidris alpina (L.) (Dunlin)	×	(×)		×	
C. canutus (L.) (Knot)				×	
C. maritima Brünn (Purple sandpiper)	×		×		×
Charadrius hiaticula L. (Ringed Plover)	×				
Cinclus cinclus (L.) (Dipper)	(×)				
Haemotopus ostralegus (L.) (Oystercatcher)	×			×	×
Larus argentatus Pont. (Herring gull)	×		×	×	
Numenius arquata (L.) (Curlew)	×				
Tringa hypoleucos L. (Common sandpiper)					(×)
T. totanus (L.) (Redshank)	×				×
Somateria mollissima (L) (Common eider)	×		×		×
Clangula hymenalis (Oldsquaw)				×	
Bucephala albeola (Bufflehead)			×	×	
B. clangula (Goldeneye)			×	×	
Aythya affinis (Lesser scaup)					×
Turdus ericetorum Turton (Song thrush)	(×)			×	
T. merula L. (Blackbird)	×				
T. musicus L. (Redwing)	×				
T. viscivorous L. (Mistlethrush)	×				
CRUSTACEA					
Cancer pagurus L. (Edible crab)	(×)			×	
Carcinus maenas (L.) (Common shore crab)	×			×	
Crangon sp. (Shrimp)	×				
Homarus spp.				(×)	×
Palaemon sp.	×				
FISH					
Acanthocottus bubalis (L.) (Seascorpion)					×
Anguilla sp (Eel)				×	
Blennius spp. (Blennies)	×				
Callionymus lyra L. (Dragonet)					×
Gadus merlangus L. (Whiting)					×
Gobius spp.				×	×
Pleuronectes flesus (L.) (Flounder)	×			×	
P. limanda (L.)					×
Pollachius virens (L.) (Pollack)				×	
MOLLUSCA					
?Busycon spiratum (Lam.)	×				
Colus stimpsoni (Mörch)				×	
Nucella lapillus (L.)	×			×	
Odostomia scalaria Macgillivray	×				
MAMMALS					
Man	×			×	
Rats	(×)			(×)	

Key: × = known prey, (×) = inferred prey.

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J. Conch. *28*: 358 (1975)

THE REDISCOVERY OF *CERASTUA LYMNAEIFORMIS* (HAAS) [ENIDAE]

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(*Read before the Society, 16 November 1974*)

Earlier this year (1974) Dr. David Brown of the Medical Research Council passed to me for examination a small collection of snails which had been collected in Tanzania by Mr. G. W. Frame on the slopes of Empakaai Crater (formerly better known as Embagai or Elanairobi Crater). Several people have collected in the Serengeti-Ngorongoro area; the late Dr. Fritz Haas dealt with the material obtained by Dr. Kohl-Larsen from which he described several new species including *Cerastua lymnaeiformis* (Haas, 1936). The type locality is 'rain forest' on the southern slopes of Ngorongoro crater at 1800 m. but to my knowledge only the single type specimen has ever previously been found; no specimens were present in any of the few collections from the area which have passed through my hands, neither was I able to rediscover it myself during my brief collecting in the area. I was, therefore, very pleased to find a single specimen of this species (easily recognisable from the description and excellent figure given by Haas) in the collection sent by Mr. Frame. The exact data for the specimen are as follows 'Empakaai Crater, lower end of new Ngopironi (formerly Olgobroni) road, 5 Sept. 1973, bushland.' This second specimen differs but little in size from the type, measuring 27 mm. high, 13 mm. wide, aperture 11 mm. high, 8 mm. wide; Haas gives the measurements of the type of his aptly named species as 29 mm high, 12·5 mm. wide, aperture 12 mm. high, 8 mm. wide. Bibliographic details for the species are as follows:

1936 *Cerastus lymnaeiformis* Haas, in *Abh. senckenb. naturf. Ges.* **431**: 21, pl. 1, figs. 8a–b.

1967 *Cerastua lymnaeiformis* (Haas), Verdcourt, in *Rev. Zool. Bot. Afr.* **76**: 194.

Other species collected on the sides of the crater by Mr. Frame were: *Cerastua trapezoidea masaica* Verdcourt, *Conulinus daubenbergeri* Dautzenberg, *Bocageia elata* Haas var., *Oreohomorus iredalei* (Preston), *Limicolaria martensiana* Smith, *Nothapalus* sp. and *Vitrina* sp.

All the material has been presented to the Musée de l'Afrique Centrale, Tervuren, Belgium.

J. Conch. *28*: 359–364 (1975)

A FIELD GUIDE TO THE BRITISH LIMAPONTIIDAE AND *ALDERIA MODESTA* LOVÉN

(GASTROPODA: SUB-CLASS OPISTHOBRANCHIA, ORDER SACOGLOSSA)

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(*Read before the Society, 19 April 1975*)

INTRODUCTION

There are eight British species of the order Sacoglossa (Winckworth, 1932; Table 1) and three of them belong to the family Limapontiidae: *Limapontia capitata* (Müller), *L. depressa* Alder and Hancock, and *L. cocksi* (A. and H.)—also known as *Acteonia senestra* or *A. cocksi.* These species have not been well recorded in the past, though the first two are common and, at times, abundant. For example, on searching through the published records for Ireland, none could be found for *L. depressa.* Yet on a visit to Ireland during May 1974, one specimen was found within a few minutes on a narrow strip of saltings outside the Marine Laboratory at Carna, Co. Galway; and on the salt-marshes near Strangford Lough, Co. Down, *L. depressa* was abundant—it was estimated that many thousands were present.

The three species are difficult to find because they are small, inconspicuous, and seasonal. They are not easy to identify for they have few distinctive features. In modern field guides descriptions of these species are of necessity all too brief and it was thought that a more detailed treatment might be of help to non-specialists. These remarks apply also to the sacoglossan *Alderia modesta* which occurs in the same habitat as *L. depressa* and is therefore included for the convenience of collectors. Full descriptions of the four species with figures drawn to assist in their identification are given in this paper, together with some general notes, and hints on collecting and preservation. By this means, it is hoped, more naturalists will be encouraged to record and study these interesting opisthobranchs.

GENERAL NOTES

An efficient way for a small gastropod to feed on seaweeds might be to pierce each cell in turn and suck out the contents, leaving the empty husk of the cell wall behind. The cells, of course, would have to be large enough to make the effort worthwhile. Some seaweeds are not composed of cells but have an outer

wall enclosing all the nuclei and cytoplasm, and of these some have in addition a few cross walls. They form a group known as the Siphonales which includes *Vaucheria, Codium, Caulerpa* and *Cladophora.* A gastropod could obtain a much greater volume of protoplasm from these seaweeds with far less effort than if it were to feed on cellular algae.

Most sacoglossans feed on siphonaceous algae; they have teeth specially adapted for piercing plant walls and the buccal mass includes a suction pump for withdrawing the sap. Each species feeds on only one or two species of algae and this makes the collecting of sacoglossans somewhat easier.

TABLE 1

List of British Sacoglossa

1. *Limapontia depressa* Alder and Hancock	5. *Hermaea dendritica* (Alder and Hancock)
2. *L. capitata* (Müller)	6. *H. bifida* (Montagu)
3. *L. cocksi* (Alder and Hancock)	7. *Elysia viridis* (Montagu)
4. *Stiliger bellulus* (Orbigny)	8. *Alderia modesta* (Lovén)

L. depressa and *A. modesta* are found on salt-marshes on damp mud well clear of the brackish water of pools and gullies, and hence they are almost terrestrial. They show two adaptations for life on land—a thick coat of mucus to prevent water-loss and a sub-terminal anus for the efficient removal of faecal matter. Both species have been found on the lower border of the marsh living in water left by the receding tide, so they could be called amphibious. It would be interesting to find out if their range extended still further to a depth of one or two metres below the extreme low level of spring tides. Populations at this depth might show morphological and physiological differences when compared with those living at the terrestrial end of the range.

HINTS ON COLLECTING

L. capitata and *L. cocksi* feed on light or dark green *Cladophora* that grows in shallow rock pools on the upper part of the shore. These pools are often surrounded by a wide margin of green algae that dries out when the tide ebbs. *Cladophora* grows best in pools on flat, shelving rocks of limestone, sandstone, or granite. Thus knowing the type of shore, the kind of pool, and the particular seaweed to look for, the search for *L. capitata* and *L. cocksi* is not so difficult as at first sight it may appear.

Having chosen a suitable pool or runnel, kneel down on a pad (an old newspaper folded up will do quite well) and examine carefully *Cladophora* filaments for velvety-black sea-slugs about 5 mm in length. If you attempt to collect a specimen of *L. capitata* or *L. cocksi* by means of forceps, it usually secretes a slippery mucus, contracts into a circular blob, and so escapes. A better method is to break off the filament behind the animal thus avoiding the escape reaction.

The procedure for *L. depressa* is similar. It is known to feed on *Vaucheria,* so select on a salt-marsh an area of mud that has a greenish tinge to the surface

and look for minute slug-like animals that glisten with mucus. Try pushing aside the stems of Seablite, *Suaeda maritima* (L), or Sea Purslane, *Halimione portulacoides* (L.), for sometimes *L. depressa* seeks protection under the cover of these plants. A search could be made along the lower border of the marsh and, if practicable, beyond this.

It is well to make certain with a pocket lens that your first specimens are, in fact, sacoglossans. Look for the pale patches with eye spots on the sides of the head—a key mark of the Limapontiidae; then see if tentacles are present—if not, determine the position of the anus. Minute bivalves, particles of coal dust, and the rissoid *Skeneopsis planorbis* have all been mistaken for *L. capitata* and *L. cocksi,* and the black seeds of Seablite for *L. depressa.*

Since *A. modesta* feeds on *Vaucheria* it occurs in the same habitat as *L. depressa,* though it is less common, more seasonal, and often inconstant in its occurrence in any given locality. When picked up it looks slightly broader than *L. depressa* and its cerata may just be seen under a coat of mucus, giving the posterior end of the animal a mulberry-like appearance. Examination with a lens will confirm the features given in the description on p. 363.

When collecting on or near salt-marshes some naturalists may have the good fortune to find *Stiliger bellulus,* a sacoglossan which has not been recorded since the turn of the century (Farran 1905). It looks like a slender *Alderia* with fewer cerata and has a pair of short tentacles and a tapering tail. Its rediscovery would be a most welcome event.

The best time for collecting is in the months of March, April and May. By the end of August most sacoglossans are scarce. Since *L. cocksi* has no free-swimming larval stage it should be found at all times of the year, but one has to know a particular area quite well to be reasonably certain of finding a specimen in winter. It should not be collected, and even in spring only a few should be taken, since this species is uncommon.

PRESERVATION

L. capitata is a hardy animal and will live in a bottle of seawater for two or three months; *L. cocksi* is not so tough and will last about a fortnight; *L. depressa* and *A. modesta* require a little of the green mud kept moist with brackish water. The animals are very contractile and it is essential to relax them before preservation. This may be done by adding a little M.S.222 Sandoz to the water in which they live—add just sufficient to cause them to stretch out in about a quarter of an hour. When they do not respond to the touch of a needle they may be transferred to 70% alcohol or Bouin's fluid. If desired, the identity of *L.depressa* may be checked by preparing a mount of the penial style and examining it with a microscope. The style of *L. depressa* is shaped somewhat like a teapot spout, the opening is long and there are three or four spines on the inner curve of the shaft; the style of *L. capitata* is less curved, the opening is not so extensive and the shaft bears no spines (Gascoigne 1956; 1974).

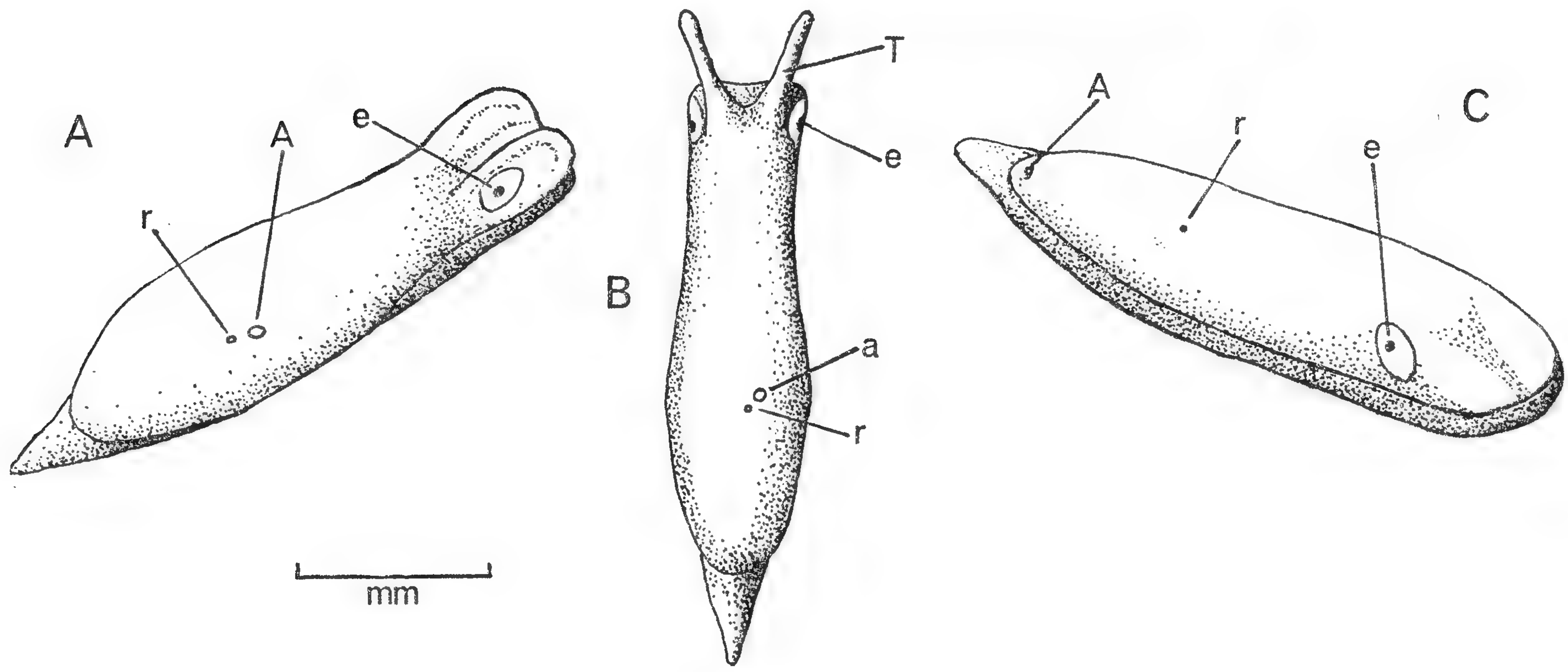

Fig. 1. A – *Limapontia capitata*: B – *L. cocksi*; C – *L. depressa* A or a, anus; e, eye; r, renal opening; T, tentacle. Key characters for each species indicated by capital letters.

DESCRIPTIONS

In the following descriptions key characters are printed in italics.

Family Limapontiidae

2–10 mm long and about one quarter of this in breadth; of slug-like shape; body contractile; no cerata or gills; *two prominent eyes each set in a pale patch on the side of the head*; foot extending beyond the visceral mass in a tail; colour, black—due to a melanin pigment contained in the epidermal cells; if the pigment is not strongly deposited the colour may be brown to light-fawn; usually with a head-pattern of a median black stripe on a pale background; anus and renal opening on, or to the right of, the mid-dorsal line; male opening just behind the eye patch on the right side.

Key to the species of Limapontiidae.

1.	A pair of tentacles on the head..	*L. cocksi*
	Tentacles absent	(2)
2.	Anus near the posterior end of the body	*L. depressa*
	Anus one third the way along the body from the posterior end	*L. capitata*

The following species descriptions are based on those given by Alder (1869).

L. depressa (Fig. 1C)

Body depressed; head rounded and without prominent lateral crests; anus and renal opening wide apart, *anus placed in a slight depression near the end of the body,* renal opening about a quarter of the length of the body from the posterior end and close to the mid-dorsal line; thickly coated with mucus; occasionally with minute yellowish-white dots over the body; a common albino variety (var. *pellucida*) lacks melanin and so it appears translucent yellow with the green lobes of the gut showing through; moves sluggishly.

Habitat: salt-marshes, from the level of spring tides down to the wet mud on the lowest part of the marsh; never far from its food plant *Vaucheria.*

Common, often abundant.

L. capitata (Fig. 1A)

Head with two lateral crests that arch from behind forwards; *anus about one third the length of the body from the posterior end*; renal opening smaller than the anus and nearer to the mid-dorsal line; sometimes with a pale area over the heart region or a few light fawn spots along the mid-dorsal line or along the sides; rarely strays from its food plant *Cladophora*.

Habitat: rock pools and runnels in which *Cladophora* grows; from top-shore to mid-tide level, more frequently found near the top shore.

Common, often abundant.

L. cocksi (Fig. 1B)

Body more slender than in the other two species; head with *a pair of cylindrical tentacles* of moderate length; anus and renal opening close together; sometimes with pale area and light-fawn spots as for *L. capitata*; active, often seen crawling on the floor of a pool.

Habitat: has the same habitat as *L. capitata*.

Uncommon, occasionally abundant.

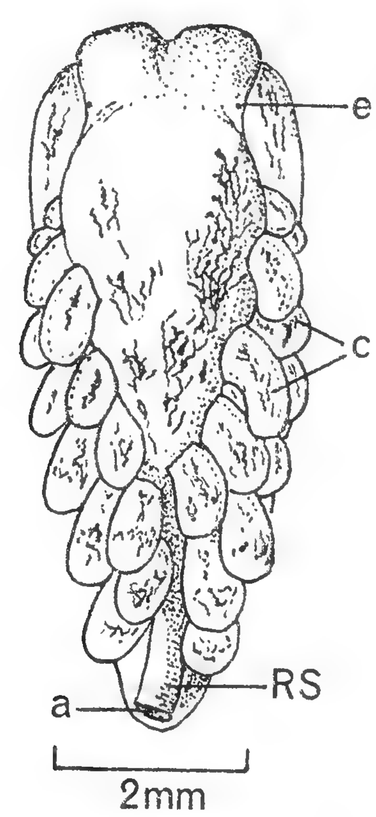

Fig. 2. *Alderia modesta*; a, anus; c, cerata; e, eye; R.S., rectal spout.

Alderia modesta

2—10 mm long; body slug-like; foot broad anteriorly; colour variable, yellowish, greenish, or brown, with a network of streaks and blotches of black or brown; head small, indented in front and produced at the side into two rhinophoral lobes; eyes wide apart, set laterally just behind the lobes; cerata usually swollen at the ends but can vary in shape, arranged in slanting longitudinal rows on the sides of the body, leaving a raised triangular area of the dorsal surface free; about 15 cerata each side, the number varying with size and age of specimen; *a rectal spout extending to the end of the body*; male opening on the right side of the head.

Habitat: salt-marshes, as for *L. depressa*.
Uncommon, sometimes locally abundant.

ACKNOWLEDGEMENTS

I am grateful to Dr. H. O. Bull who first introduced me to these interesting sacoglossans and to Professor A. Graham for reading the manuscript.

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J. Conch. *28*: 365–369 (1975)

DYMANTIC DISPLAY IN *GALEOMMA POLITA* DESHAYES (BIVALVIA: LEPTONACEA)

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(*Read before the Society, 15 March 1975*)

INTRODUCTION

The early mollusc was protected by its shell. Rapid withdrawal of the head and foot, the latter often sealing the orifice of the shell with an operculum, can be envisaged as a primitive defensive mechanism. Subsequently other defensive mechanisms evolved largely associated with the reduction or loss of the shell in various molluscs.

Gastropods such as the tropical planktonic *Glaucus* may blend into their background, whilst shell-less lamellariids may resemble their normal substratum, their prey or some other irrelevant organism (Thompson, 1973). Other gastropods exude a noxious (usually acid) defensive secretion from the mantle when disturbed (Thompson, 1960, 1969; Lloyd, 1970); yet more can autotomise portions of the body (Stasek, 1967).

In the cephalopods too, where the shell is internal, highly sophisticated patterns of chromatophore display have evolved and the animal can change colour to match its surroundings. Kuhn (1950) demonstrated this experimentally. Some cephalopods can autotomise pieces of their arms (Stasek, 1967), whilst more commonly a discharge of either black ink in coastal species or luminescent ink in benthic species is utilized to confuse the predator whilst the animal makes good its escape. When cornered, however, Holmes (1940) has shown that *Sepia* exhibits a dymantic or "terrifying" response in which the animal pales and flattens out expanding the chromatophores around the eyes and the interbranchial web. A similar response is seen in *Octopus* (Wells, 1962).

In the Bivalvia similar adaptations are seen; again autotomy is frequently encountered (Stasek, 1967) and is often associated with the release of a noxious substance from the automised region, e.g. *Divariscintilla maoria* Powell (Judd, 1971), *Galeomma* (*Paralepida*) *takii* (Kuroda) (Morton, 1973a). Other bivalves e.g. the burrowing *Laternula truncata* (Lamarck) cover the siphons with sand grains and possess siphonal tentacles which flick particles of sand over the edge of the siphon in order to conceal their outline, much like certain species of flatfish do when settling upon sand (Morton, 1973b). Other bivalves, e.g. *Lima, Modiolus* (Merrill and Turner, 1963) and *Musculista* (Morton, 1974), build a nest of

byssus threads. In the case of *Modiolus* this protects the brooded eggs, but in *Musculista* it protects the adult. A fish like crypsis is also seen in many swimming bivalves, e.g. *Amussium* (Thayer, 1971).

To date however, dymantic display has not been described for any bivalve.

DYMANTIC DISPLAY IN *GALEOMMA POLITA*

Galeomma polita Deshayes is comonly found under stones on sheltered, often estuarine, boulder strewn shores in Hong Kong. Its relationships, if any, with other animals are not known, but it is not thought to be commensal as are the majority of galeommatids, more probably exhibiting a loose association with other cryptic species. *Galeomma* (*Paralepida*) *takii is* found in a similar habit and exhibits a more or less similar loose association (Morton, 1973a).

Specimens of *Galeomma polita* have been collected at irregular intervals over the last three years, usually from under rocks at L.T.M. in Deep Water Bay, Hong Kong Island.

The animal (Fig. 1) is typically found attached by a few byssal threads (B) to the undersurface of the rock, often nestling inside empty rock oyster (*Saccostrea cucullata*) valves. It is dorsoventrally flattened, the reduced thin shell

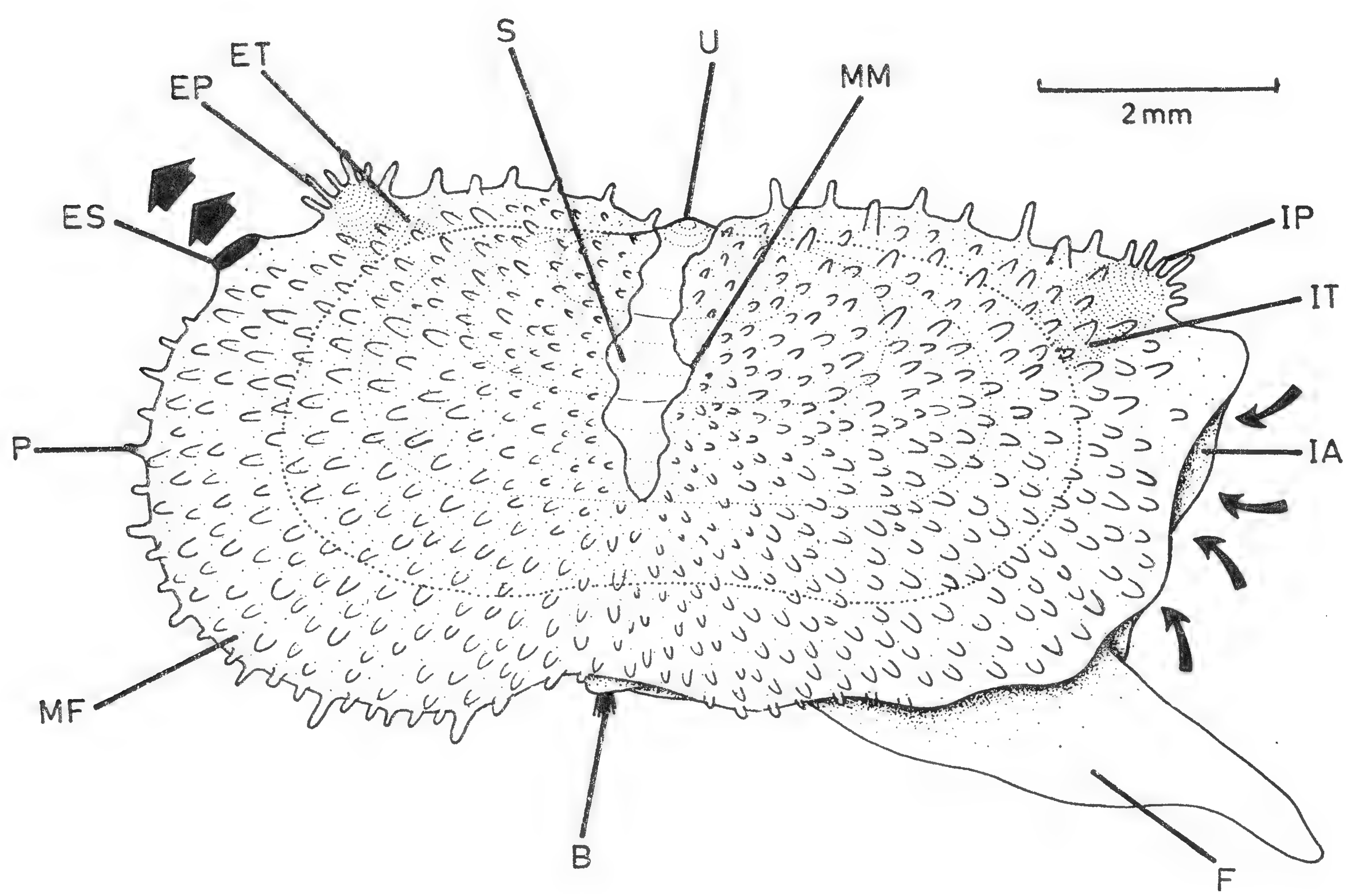

Fig. 1. *Galeomma polita* viewed from the side. Inhalant (small arrows) and exhalant water currents (broad arrows) are shown. B, byssus; EP, exhalant papillae; ES, exhalant siphon; ET, exhalant tentacle; IA, inhalant aperture; IP, inhalant papillae; IT, inhalant tentacle; MF, middle mantle fold; MM, mantle margin; P, papillae; S, shell; U, umbo.

valves possessing an enormous pedal gape. *Galeomma polita* might be considered an example of the bivalve approach to a limpet-like mode of life. There is an anterior inhalant aperture (IA) and a posterior exhalant siphon (ES). The shell is almost completely covered by the reflected middle mantle folds (MF) which possess numerous pallial papillae (P). When strongly stimulated these papillae can autotomise a distal swelling which releases presumably noxious granules. A similar process is seen in *Galeomma* (*Paralepida*) *takii* and has been described fully (Morton, 1973a).

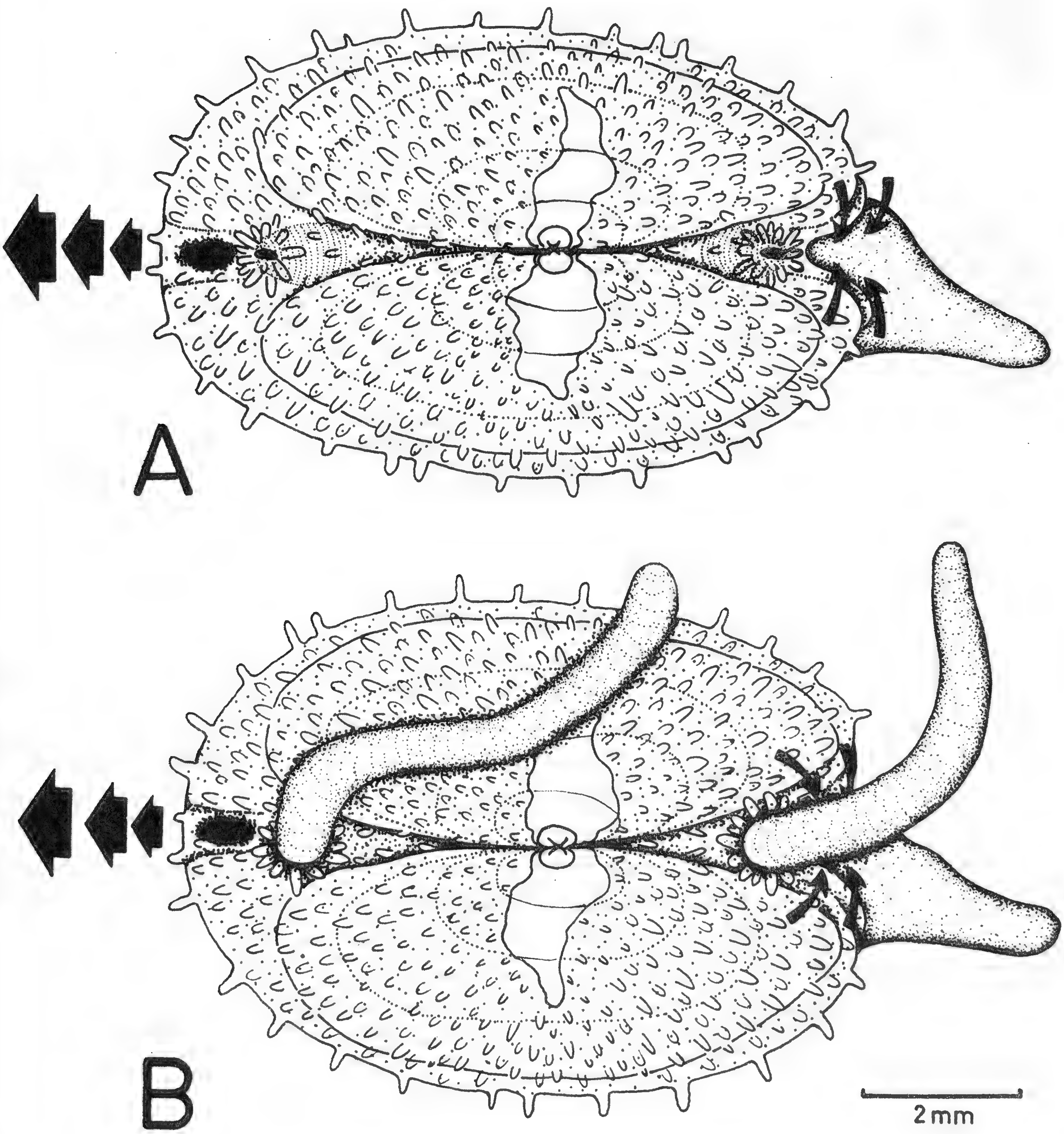

Fig. 2. *Galeomma polita*. Dorsal views of specimens with (A) tentacles retracted and (B) everted. Inhalant (small arrows) and exhalant water currents (broad arrows) are shown.

When specimens of *Galeomma polita* are prodded sharply, however, two enormous tentacles, some 6 mm long, are suddenly everted from pallial sacs immediately above the exhalant siphon and the inhalant aperture (Fig. 2). These tentacles which have been respectively called exhalant (ET) and inhalant tentacles (IT), wave vigorously above the animal for a few seconds and then retract. The apertures leading to the sac containing the tentacles are fringed by a circlet of some 10–12 smaller papillae, here termed exhalant (EP) and inhalant (IP) papillae. When contracted the tentacles can be seen within the mantle and have been shown to arise as an extension of the mantle itself. Tentacle eversion is thus probably caused by the build up of pressure within the mantle, possibly due to the pumping of blood into the pallial blood vessels, or into a central tentacular haemocoelic tube as in *Divariscintilla maoria* (Judd, 1971) and *Galeomma* (*Paralepida*) *takii* (Morton, 1973a).

DISCUSSION

Animals are characteristically camouflaged. The methods by which this is achieved are well known and examples exist throughout the phylum Mollusca. However, when threatened and no lines of retreat exist a "terrifying", "frightening" or dymantic display may be performed to divert or dissuade the predator. Dymantic display may involve either a sudden display of colour, an increase in size, an opening of the mouth, integument or wings, the erection of fans, hairs or appendages or the extrusion of filaments or tentacles. The latter would seem to apply in the case of *Galeomma polita,* and Cott (1957) and Hingston (1933) have described how in the Puss Moth larva (*Cerura vinula*) and the Indian Swallowtail caterpillar (*Papilio demoleus*) two brightly coloured, highly mobile tentacles are everted from the body and wave around when these creatures are disturbed. In *Galeomma polita* a similar reaction occurs.

The suggestion that the tentacles might remove sediment settling on the bivalve is discounted largely because *Galeomma* lives upside down on the undersurface of the boulder where a rain of sediment would not normally affect it. It is more likely that the animal relies, for a first line of defence, upon the numerous pallial papillae which can, as in *Galeomma* (*Paralepida*) *takii,* autotomise and release presumably noxious granules. Such a defensive mechanism would deter the many tiny creatures sharing this well defined niche. For more persistent attackers, however, it would seem that *Galeomma polita* relies upon a "frightening" or dymantic action that may function visually but probably functions, in the darkness of the undersurface of the stone, in a tactile way suggesting to the predator that it is attacking something quite different; perhaps an anemone.

SUMMARY

When disturbed *Galeomma polita* everts and vigorously waves two large tentacles; this is interpreted as a dymantic action.

ACKNOWLEDGEMENTS

I am grateful to Dr. John Taylor of the British Museum (Natural History) for identifying specimens of *Galeomma polita* Deshayes.

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J. Conch. 28: 370 (1975)

A SECOND SPECIMEN OF *FULGORARIA* (*PSEPHAEA*) *MEGASPIRA* (SOWERBY)

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(*Read before the Society, 19 October 1974*)

According to Weaver and DuPont (1970, p. 39) *Fulgoraria* (*Psephaea*) *megaspira* (Sowerby, 1844) was hitherto known from a unique specimen present in the British Museum, Natural History. Sowerby (1844, pp. 150–151) described the shell without mentioning its provenance.

However Reeve (1849, explanation to plate 20) wrote "The specimen here figured from Mr. Cuming's collection [i.e. Sowerby's specimen], was brought from Japan by Dr. Siebold. There is a specimen in the collection of M. Delessert in Paris, figured erroneously by Kiener for the *V. lyraeformis,* and another in the Museum at Leyden." The shell figured by Kiener (1839, pl. 42, fig. 2) clearly belongs to *Fulgoraria* (*Musashia*) *prevostiana* (Crosse 1878), as Weaver and DuPont (1970, p. 44) also stated. The third specimen mentioned by Reeve from the "Museum at Leyden", seems to have been forgotten.

While revising the Volutidae in the Rijksmuseum van Natuurlijke Historie at Leiden, I found two specimens labelled "*Voluta megaspira*" added to the collection from Japan by Dr. Ph. F. von Siebold during the period 1823–1830. They were already listed by Horst and Schepman (1908, p. 68–69) under the same name. One of the shells belongs to *F.* (*M.*) *prevostiana,* the other is a fine specimen of *F.* (*P.*) *megaspira* (pl. X), closely resembling the holotype as figured by Weaver and DuPont (1970, pl. 13, figs. E–F). It is not clear to which of the two specimens Reeve (1849) referred.

At any rate, there is a second specimen of *F.* (*P.*) *megaspira* in the Rijksmuseum van Natuurlijke Historie at Leiden in addition to the holotype in the British Museum, Natural History, London.

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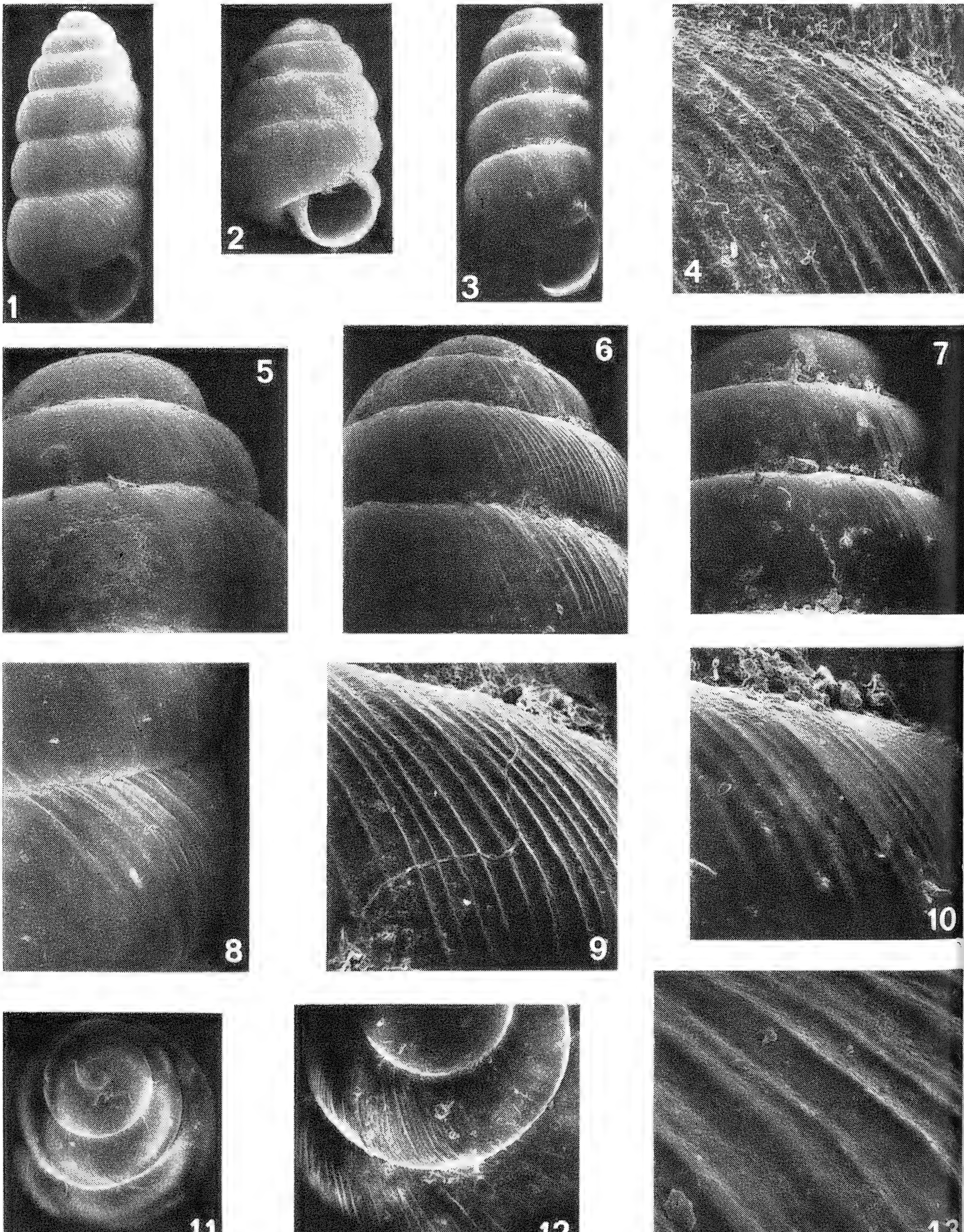
Fulgoraria (*Psephaea*) *megaspira* (Sowerby,) actual height 10·7 mm. Japan, Ph.F von Siebold coll. 1823–1830; Rijksmuseum van Natuurlijke Historie, Leiden, No. 16 1a.

Plate XI



Columella edentula (Drop.), *C. aspera* Waldén and *C. columello* (von Martens)

J. Conch. 28: 371–383 (1975)

COLUMELLA IN THE BRITISH ISLES

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(*Read before the Society, 15 March 1975*)

In 1966 Waldén (1966, p. 53) described *Columella aspera*, a new European species of the Vertiginidae and remarked that it occurred in Britain together with the well known *C. edentula* (Draparnaud). Subsequently Schmid (1967), Plate (1967), Gittenberger *et al.* (1970, p. 48) and Zeissler (1974) have recorded *C. aspera* from near Tübingen, the Island of Bornholm in the Baltic, Holland and Thuringia respectively, and have added ecological and descriptive information about the species. In addition Valovirta (1967, pp. 29, 30) lists *C. aspera* from Finland. Although Ellis (1969, p. 266) and Kerney (1973, p. 313; 1974, p. 288) have mentioned the new species briefly there has been no positive con-

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EXPLANATION OF PLATE XI

Scanning electron micrographs of *Columella* species

Columella edentula (Draparnaud)

Fig. 1. Apertural view of mature adult shell to show outline. × 19. Bergin's Bridge, Co. Offaly, Ireland (N/584112).
Fig. 5. Details of apex to show relatively smooth whorls. × 66·5. Ballinasloe, Co. Galway, Ireland (M/83) National Museum of Ireland.
Fig. 8. Details of lower whorls to show relatively smooth surface. × 66·5. Same shell as Fig. 1.
Fig. 11. Details of apex of juvenile shell. × 38. Bergin's Bridge, Co. Offaly, Ireland (N/584112).

Columella aspera Waldén

Fig. 2. Apertural view of mature shell to show outline and striated surface. × 19. Annamoe, Co. Wicklow, Ireland (O/176005)
Fig. 4. Details of surface sculpture of periostracum on lower whorls. × 189. Kenbane, Co. Antrim, N. Ireland. National Museum of Ireland.
Fig. 6. Details of apex of shell to show characteristic striations which commence on the second whorl. × 66·5. Gressenhall, Norfolk.
Fig. 9. Details of sculpture on lower whorls. Note the regular striations. × 189. Same shell as Fig. 6.
Fig. 12. Details of apex of juvenile shell to show onset of characteristic striations on second whorl. × 66·5. Annamoe, Co. Wicklow, Ireland (O/176005).
Fig. 13. Details of periostracum on lower whorls. × 567. Same shell as Fig. 2.

Columella columella (Martens)

Fig. 3. Apertural view of mature shell to show outline and "shouldered" whorls. × 19. Sør Trøndelag, Norway.
Fig. 7. Details of apex of same shell. × 66·5.
Fig. 10. Details of sculpture on lower whorls of same shell. × 189.
Unless otherwise stated all shells illustrated are now in the collections of the British Museum, Natural History, London. All photographs taken on a scanning electron microscope at Reading University, specimens plated with gold.

firmation of Waldén's assertion that two species of *Columella* inhabit the British Isles. No account of the shell characters and ecology of *C. aspera* has been published in English nor has the species been illustrated photographically. This note attempts to remedy these deficiencies.

A large series of *Columella* samples collected from a variety of habitats in central and eastern Ireland in April 1971 confirmed Waldén's assertion. Subsequently, through the kindness of numerous colleagues, the study has been extended broadly over the British Isles with the following results:

1. There are two quite distinct species of *Columella* living in Britain: *C. edentula* (Draparnaud) and *C. aspera* Waldén. The two species can be distinguished easily on shell morphology and ecology.

2. Both species are equally widespread throughout the British Isles but *C. edentula* generally occurs in greater numbers than *C. aspera* and prefers eutrophic, damp, calcareous habitats. *C. aspera* is characteristic of poor, oligotrophic, acid habitats, and is more common in the north and west.

3. *C. edentula* becomes more slender westwards within the British Isles whereas *C. aspera* shows less variation in shell width and no consistent geographical trends in variation.

4. The arctic-alpine species *C. columella* (Martens), although a widespread and common late glacial fossil (e.g. Kerney 1963, 1966; Sparks 1957) is now probably extinct in Britain.

My sincere thanks go to Mr. J. F. Peake, British Museum, Natural History; Dr. M. J. Bishop, Cambridge University Zoological Museum; Mr. A. Norris, Leeds City Museums; Mrs. N. F. McMillan, Merseyside County Museums; Dr. C. E. O'Riordan, National Museum of Ireland; Mr. S. P. Dance and Dr. J. E. Chatfield, National Museum of Wales; Dr. D. Heppel, Royal Scottish Museum; and Mrs. H. Ross, Ulster Museum, for the loan of, or access to, material in their care. Dr. M. P. Kerney, Imperial College, London University, kindly loaned fossil *Columella* material and Dr. H. W. Waldén provided specimens of recent *C. columella* which are now deposited in the British Museum, Natural History. Many other friends and colleagues, far too numerous to mention individually, have greatly improved the coverage of the distribution maps by submitting samples from all over the British Isles. Finally without the encouragement and assistance of Dr. Waldén, Naturhistoriska Museum, Göteborg, Sweden this study would not have materialised.

DESCRIPTION

Shells of the genus *Columella* are cylindrical, small, usually less than 3·0 mm high by 1·5 mm maximum diameter, thin and have five to eight tumid whorls. Unlike most species of the related genus *Vertigo,* the aperture is not provided with any denticles at all, nor is it thickened, folded or significantly expanded or reflected. It is not easy, therefore, to distinguish mature shells from juveniles and there is no defined maximum size. Apparently shells continue to grow throughout life although more slowly and intermittently after the onset of maturity. There

are few clear cut shell characters on which to distinguish species which perhaps partly explains why *C. aspera* has been overlooked for so long even in Europe, the very part of the world in which non-marine molluscs have been intensively studied for the longest period of time. A combination of subtle shell characters and distinct ecological preferences indicates that there are three separate species of *Columella* in Europe, two of which are certainly found living in Britain.

C. edentula (Draparnaud) Plate XI, figs. 1, 5, 8, and 11; Text-fig. 1.

The body is slender, grey, darker above, paler behind and laterally, with a pale sole. Only the upper pair of tentacles is present; they are rather short and smooth with very darkly pigmented retractor muscles visible within.

The shell is nearly cylindrical, thin, transluscent and glossy (Plate XI, fig. 1). Fresh shells are pale yellow brown but become less transluscent and greyish with age and may lose part of the periostracum. The protoconch is about $1\frac{1}{2}$ whorls (Plate XI, fig. 11); below this the shell may be ornamented with fine weak irregular corrugations parallel to the edge of the aperture but some shells are almost completely smooth (Plate XI, figs. 5, 8). There are six to seven regularly rounded or slightly flattened whorls in adult shells (Fig. 1). The first 2–3 increase in diameter fairly rapidly and regularly to form a conical apex. Lower whorls expand much less rapidly or scarcely at all forming the cylindrical outline characteristic of *Columella* species. However the last whorl may expand more rapidly than preceding whorls (Figs. 1D, 1H) which is one sign of maturity in *C. edentula.* The suture is generally deeply impressed but usually less so than in either *C. aspera* or *C. columella.*

The aperture is rounded or oval with the height greater than the width, and forms about two thirds of a circle. There are no teeth or folds. The outer lip lacks an internal rib and is not reflected. The columella is generally straight but may be slightly curved and the lower columellar lip is reflected over the narrow and very deep umbilicus. Parietal callus is very thin.

Usual dimensions in British shells: Length (height) 2·0–2·5 mm (maximum in Britain 3·3 mm). Width 1·20–1·45 mm (maximum 1·65 mm).

Occurrence: Hygrophilous and eutrophic habitats are greatly preferred. *C. edentula* occurs in damp woods, river valleys, flood plains, etc. with rich ground vegetation. It avoids acid and oligotrophic habitats and places which dry out in the summer.

C. aspera Waldén Plate XI, figs. 2, 4, 6, 9, 12–13; text-fig. 2.

Body: no differences from *C. edentula* have been detected.

Shell: Very similar to that of *C. edentula* but shorter and relatively fatter (Plate XI, fig. 2; text-fig. 2), silky rather than glossy. Corrugations, which commence at $1\frac{1}{2}$ whorls (Plate XI, fig. 12), are much more regularly developed and more prominent especially on the second to fourth whorls (Plate XI, figs. 6, 9). Thus even quite juvenile shells can be separated from those of *C. edentula.* The initial whorls expand more rapidly than in *C. edentula* and the main body of the shell is even more regularly cylindrical. However since the shell is shorter this

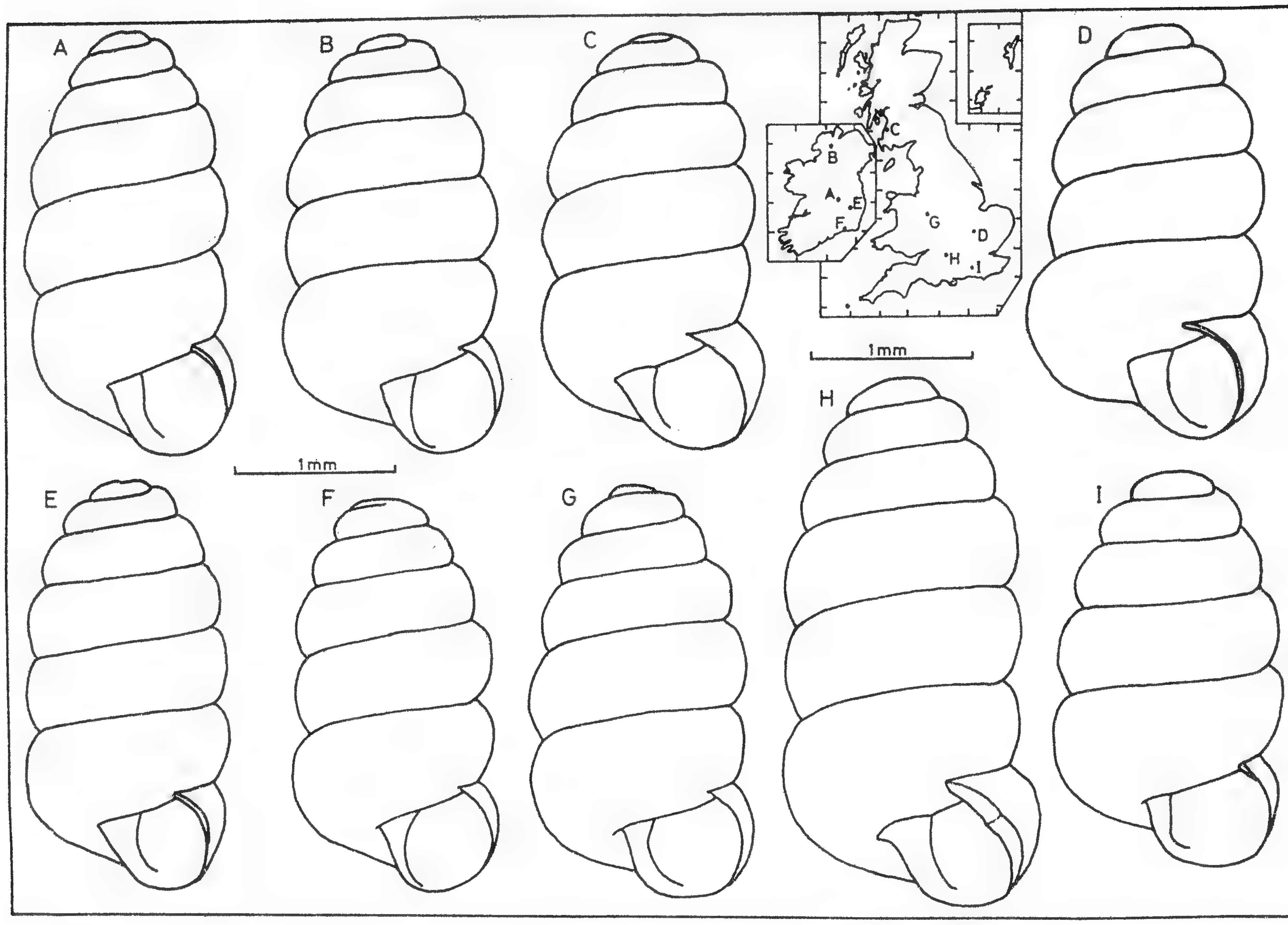

Fig. 1. Camera lucida drawings of randomly selected individuals of *Columella edentula* (Draparnaud) from populations throughout the British Isles. Note that shells tend to be more slender in western localities.
A Bergin's Bridge, Co. Offaly, Ireland (N/584112); B Royal School, Enniskillen, Co. Fermanagh, N. Ireland (H/24); C Craighead quarry, Ayrshire, Scotland (26/234013); D Hayley Wood, Cambridge (52/2952); E Tullow, Co. Carlow, Ireland (S/848733); F Waterford Harbour, Co. Waterford, Ireland (S/60); G. Tibberton, Salop (33/6822); H Chilton Foliat, Wiltshire (41/292713); I Capel, Surrey (51/179383). Figures in brackets are Irish and British National Grid references.

is not immediately apparent. There are 5–6 whorls only (Fig. 2) and the last never expands as in *C. edentula* or *C. columella.* The whorls are more strongly rounded, the suture more deeply impressed and the aperture more nearly perfectly circular in outline in *C. aspera* than in *C. edentula* (Plate XI, fig. 2; also cf. text-figs. 1 and 2). Shell colour varies from nut brown to olive brown and fresh shells are not as transluscent as those of *C. edentula.*

Usual dimensions in British shells: Length (height) 1·5–2·0 mm (maximum in Britain 2·6 mm). Width 1·30–1·45 mm (maximum 1·50 mm).

Occurrence: Prefers acid, oligotrophic habitats such as peat bogs (Ireland), moorland and even pine woods in Europe. Damp sites are preferred but *C. aspera* appears to be less affected by drying out than *C. edentula.*

C. columella (Martens) Plate XI, figs. 3, 7, 10.

Body: not seen, no live specimens available.

Shell: Differs from both preceding species in having a larger dome-shaped or hemispherical apex (Plate XI, figs. 3, 7), more obviously cylindrical outline due to its length, and more tightly coiled whorls often with a shouldered profile (Plate

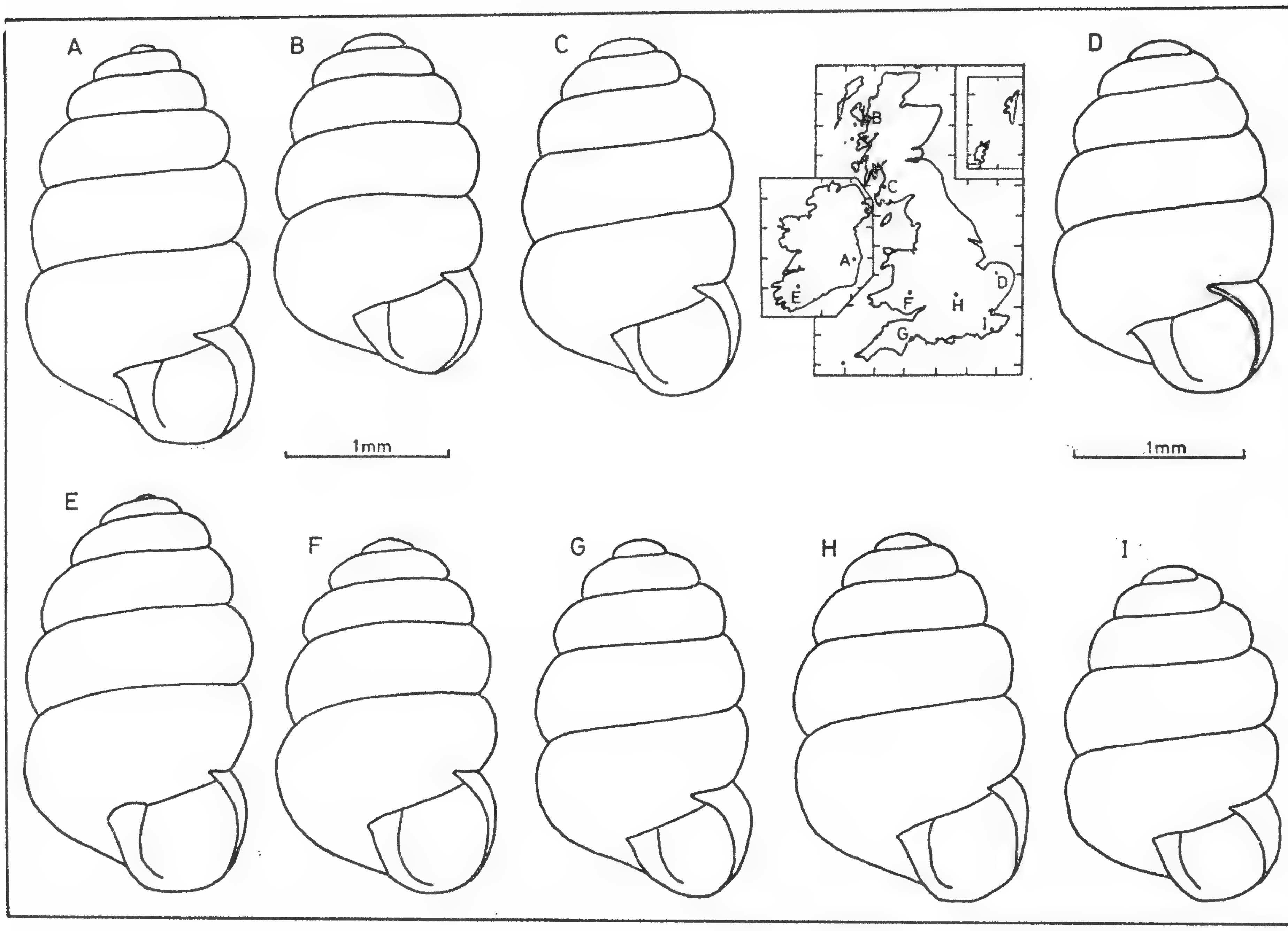

Fig. 2. Camera lucida drawings of randomly selected individuals of *C. aspera* from populations throughout the British Isles. Note that *C. aspera* is consistently shorter than *C. edentula* and that western shells are no more slender than eastern ones.

A Laragh, Co. Wicklow, Ireland (T/19); B Loch Cill Chriosd, Skye (18/605201); C Craighead quarry, Ayrshire, Scotland (26/234013); D. Gressenhall, Norfolk (53/9716); E. Blueford, Co. Cork, Ireland (R/20); F Alltmawr, Breconshire, Wales (32/0746); G Sidmouth, Devon (30/1587); H Syresham, Northamptshire (42/6542); I Battle, Sussex (51/739147).

1, fig. 3). The protoconch is larger than in either *C. aspera* or *C. edentula.* There are 7–8 whorls, the last often expanded as in *C. edentula.* The suture is deeply impressed, corrugations are irregular and the surface is shiny (Plate XI, figs. 3, 7). The aperture is oval, the columella straight and the shell colour more closely resembles that of *C. edentula* than that of *C. aspera.*

Length 2·50–3·25 mm. Width 1·30–1·52 mm (British fossil examples).

Occurrence: currently found in arctic-alpine areas on high calcareous, damp, exposed situations. Rarely in woods, sometimes above the tree line. As a fossil in Britain known from late glacial and possibly earlier deposits in southeast England. However Waldén (1966, p. 52) states that most, perhaps all, records in the literature of *C. columella* from northern Scandinavia are based on shells of *C. edentula.* The same may well be true of British fossil *Columella* and hence without re-examination of the original material, past records should be regarded as unconfirmed. Certainly it cannot be over-emphasized that great length alone is not diagnostic of *C. columella.* Forcart (1959) considered form *gredleri* to be distinct but Waldén (1966, p. 53) doubts this.

COMPARISONS

C. columella is a fairly distinctive species which may just possibly survive in calcareous habitats on the highest Scottish mountains. The report of *Columella* from 3350 ft. (over 1000 m) on Ben Lawers (Jackson 1948, Dance 1972) strengthens this possibility but the original shells appear to have been lost and Mr. Dance failed to relocate the species. The following comparisons are therefore confined to *C. aspera* and *C. edentula* both of which are widespread and common in suitable habitats in the British Isles. *C. aspera* and *C. edentula* differ in the following respects:

1. Size: *C. aspera* rarely, if ever, exceeds 2·6 mm long and mature specimens are usually 1·5–2·0 mm. *C. edentula* reaches 3·3 mm long in Britain (3·7 mm in Scandinavia, Waldén 1966, p. 52) and mature specimens are 2·0–2·75 mm (cf. Figs. 1 and 2). *C. edentula* varies in mean width of the last whorl from 1·40 mm in eastern and central England to 1·20 mm in Ireland (Figs. 1, 5); extreme examples range from 1·15 mm to 1·65 mm. In contrast *C. aspera* is usually 1·30–1·45 mm wide although colonies of narrower individuals do occur in Ireland and elsewhere.

2. Ornament: *C. aspera* has a relatively rough surface sculpture of closely and evenly spaced, fine corrugations which commence at about $1\frac{1}{2}$ whorls and continue to the aperture (Plate XI, figs. 6, 9). The surface is usually silky or matt. *C. edentula* is very shiny when fresh, has fewer, generally much weaker, and less regularly developed corrugations and some examples are almost completely smooth (Plate XI, figs. 5, 8).

3. Colour: the shell of *C. aspera* varies from dull earthy-brown to olive coloured and is usually less transluscent than that of *C. edentula* even when first formed. The shell of *C. edentula* is yellow-brown to pale chestnut-brown.

4. Habitat: *C. aspera* occurs in acid oligotrophic habitats: peat bogs, pine and oak woods, heaths, etc. It is rarely as abundant as *C. edentula* which prefers damp calcareous eutrophic habitats such as canal banks, river flood plains, damp deciduous woods (particularly ash, *Fraxinus excelsior*) and calcareous fens.

5. Association: although Boycott (1934, p. 34) stated accurately that there were probably no specific plant/mollusc associations among British non-marine molluscs and neither are there any mollusc/mollusc associations, nevertheless certain generalizations may be made about plant and mollusc associates of species of *Columella.*

The dominant species of trees in woods determine to some extent the richness of the soil. Leaf litter of some trees, notably beech (*Fagus sylvatica* 1.) and pine (*Pinus* spp.), produce acid residues on decaying and tend to leach the soil. Leaf litter of other trees, notably ash (*Fraxinus excelsior* L.), contains adequate bases to neutralise the acids and enrich the soil in bases. Oaks (*Quercus* spp.) produce intermediate residues. Thus one could predict, and finds in practice, that *C. aspera* occurs in beech and pine woods, while *C. edentula* occurs in mixed deciduous woods especially under ash trees. Oak woods sometimes support both species. The living area of a colony of *Columella* may extend over only a few square metres. Isolated colonies may therefore occur in otherwise unsuitable habitats.

I have found, for example, *C. edentula* living in moss under an ash tree and *C. aspera* among sedges (*Carex sylvatica* Hudson) under alder trees (*Alnus glutinosa* (L.) Gaertner) in different parts of the same wood near Loddon Court, Berks. Similarly, in Wasing Wood, Berks., both species occur in very wet ground under alders at the upper limits of an artificial lake, presumably where nutrients accumulate as the flow of the stream is checked by the lake. Frequently *C. edentula* is confined to valleys in areas where *C. aspera* is widespread (cf. Schmid 1967, p. 157).

In woods *C. aspera* may be collected under woodrush (*Luzula*) and is frequently found in association with *Vertigo substriata* (Jeffreys), *Acanthinula lamellata* (Jeffreys) and even the calcifuge *Zonitoides excavatus* (Alder). *C. edentula* occurs among moss and dense ground herbage in sufficiently damp localities and may be associated with *Acanthinula aculeata* (Müller), *Azeca goodalli* (Fér.), *Pomatias elegans* (Müller), *Acicula fusca* (Mont.) and other moderately to strongly calcicole species. In Hayley Wood, Cambridge, a mixed deciduous wood with oak and ash standards and hazel (*Corylus avellana* L.) and hawthorn (*Crataegus oxyacanthoides* Thuillier) coppice, *C. edentula* occurs mainly in damp sites with either *Carex riparia* Curtis or *C. sylvatica* Hudson (Paul 1975, p. 316).

In marshes and wet fields etc. *C. aspera* is associated with rushes (*Juncus* spp.) and a poor mollusc fauna: *Punctum pygmaeum* (Drap.), *Euconulus alderi* (Gray), *Retinella radiatula* (Alder). Both species are found among sedges (Carex spp.), flags (*Iris pseudacorus* L.) and grasses but neither is common in reed beds (*Phragmites*). *C. edentula* occurs among sedges and flags with a rich mollusc fauna: the previously mentioned species plus *Carychium* spp., *Zonitoides nitidus* (Müller), *Lymnaea truncatula* (Müller), *Pisidium personatum* Malm and other vertiginids. Where other vertiginids are present their distribution on the vegetation is noteworthy. *Vertigo antivertigo* (Drap.) and *V. substriata* (Jeffreys) occur low on the sedges, even under water. *V. pygmaea* (Drap.) and *C. edentula* occur higher up on stems and leaves while *V. moulinsiana* (Dupuy) occurs highest of all. The latter three species can be collected easily by sieving the vegetation but the former pair can only be collected by gathering wet litter, drying it and sieving when dry. Along canal banks and margins of fens etc., *V. pygmaea* extends further out of the damp than *C. edentula*. *C. aspera* may occur in peat bogs and also on open heaths with *Zonitoides excavatus* among *Calluna vulgaris* (L.). *C. edentula* does not occur in either habitat.

DISTRIBUTION

Both living species occur throughout the British Isles. They become more restricted in the drier, more populated southeastern counties of England but this is mainly due to human interference (drainage and forest clearance). Although there are fewer suitable habitats for *C. edentula* in the more mountainous districts of the northwest, it is still widespread but generally restricted to valleys. *C. aspera* becomes more common in these areas. Figs. 3 and 4 illustrate the available information on the distribution of both species. They are based entirely on records

confirmed by either Dr. Waldén, Dr. Kerney or myself. Too few such records exist as yet to give a reliable pattern of distribution for either species and the maps call for some comment. One or other species probably occurs in 95% or more of the 10 km squares in Britain, (i.e. in all but the most inhospitable highland and urban areas). Both species are therefore seriously under recorded. The relatively dense patches of records (e.g. *C. edentula* from northwest Ireland or south central England) reflect fairly intense recent collecting rather than real concentrations. Similarly the numerous old records around Edinburgh do not indicate

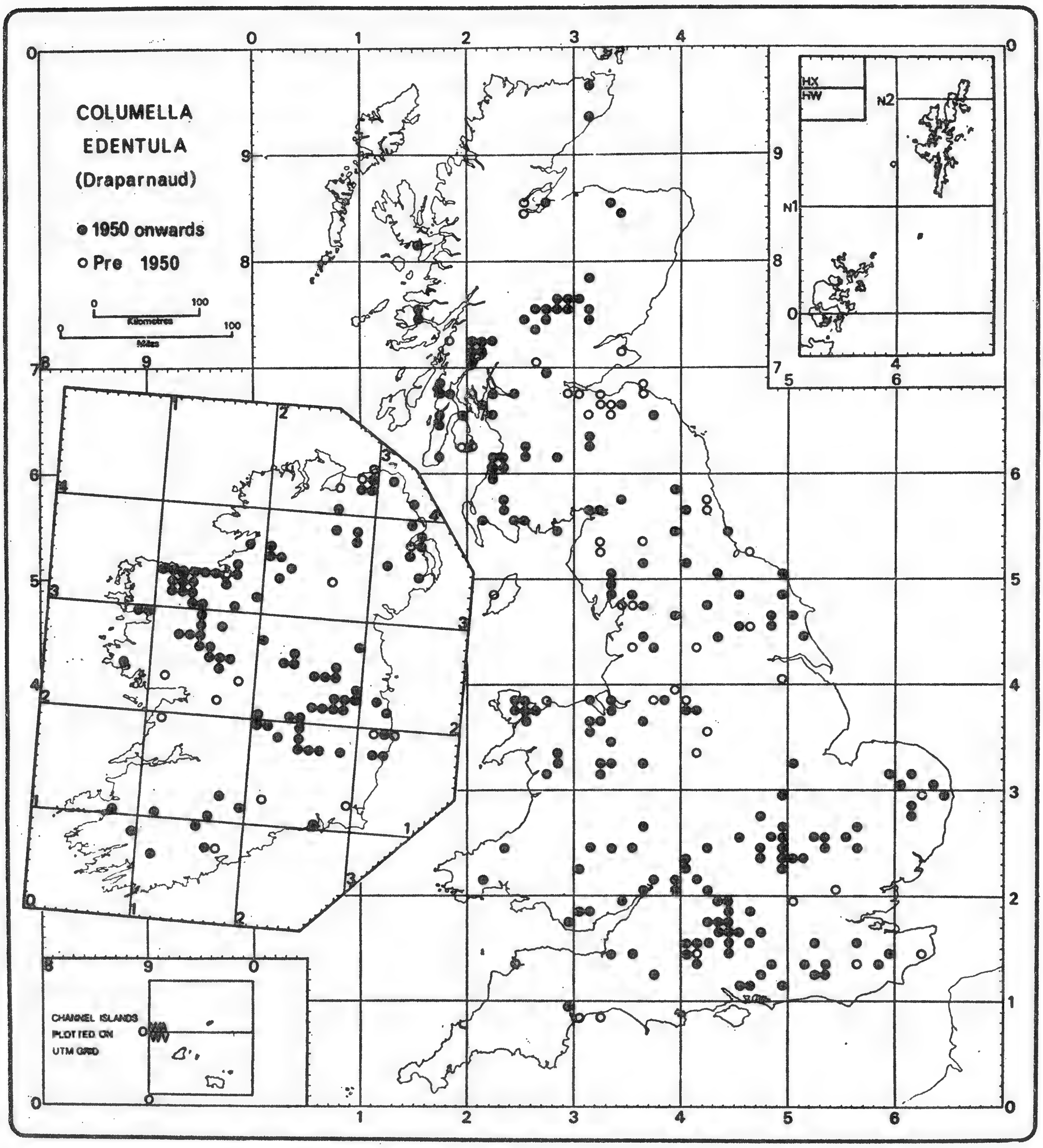

Fig. 3. Distribution map for *C. edentula* (Draparnaud). All records verified by Dr Waldén, Dr. Kerney or the author.

that *C. edentula* is dying out in this area but rather that no one has recently confirmed the collecting done by D. K. Kevan and A. R. Waterston between the Wars. It is significant that a similar pattern of concentration occurs for *C. aspera* in these areas. The fact that *C. aspera* is more common than *C. edentula* in Perthshire is probably real but again the high densities of records are due to recent collecting. There is clearly ample opportunity for further recording of both species and I would be grateful to see additional specimens from anywhere in the British Isles.

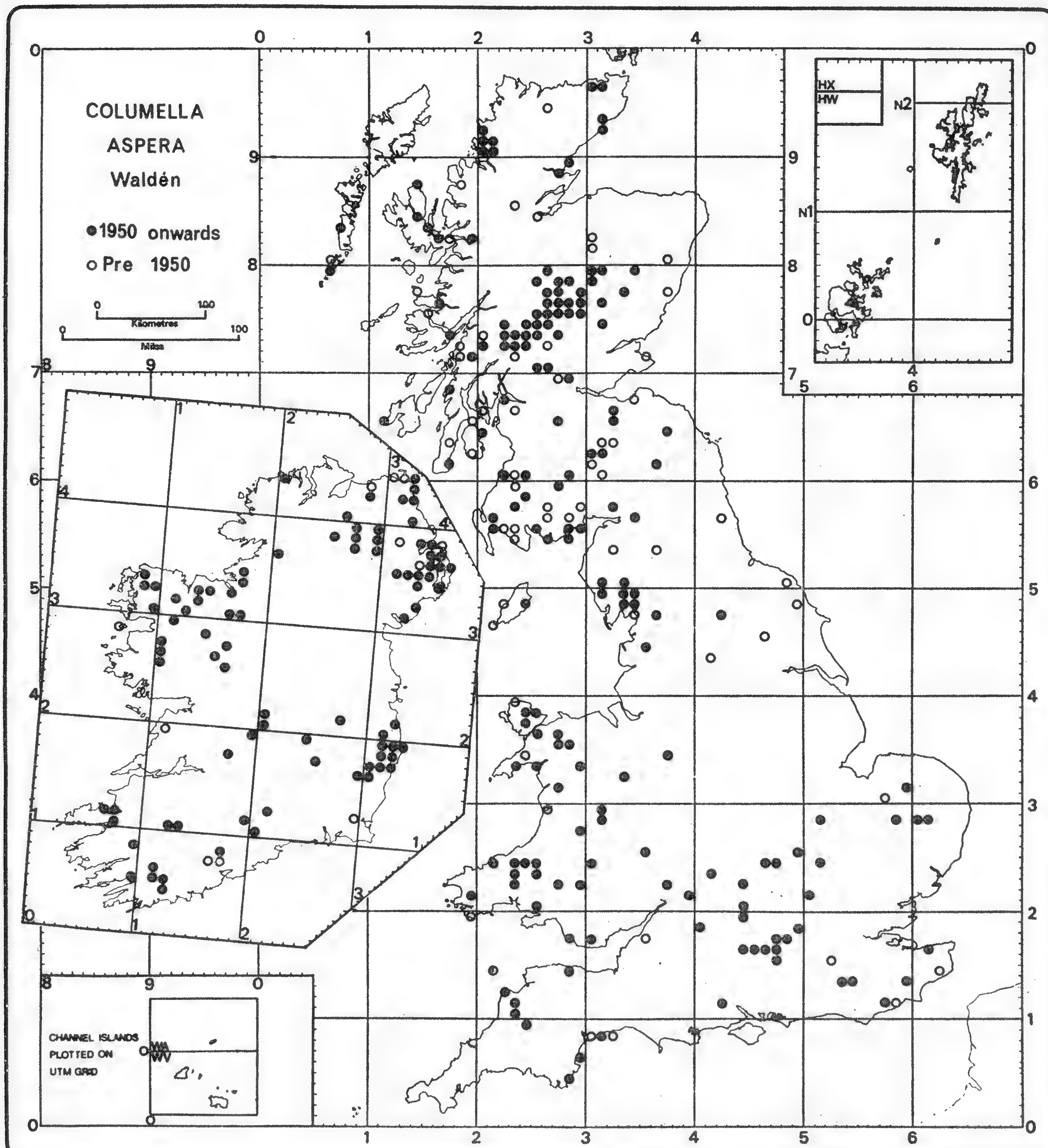

Fig. 4. Distribution map for *C. aspera* Waldén. All records verified by Dr. Waldén, Dr. Kerney or the author.

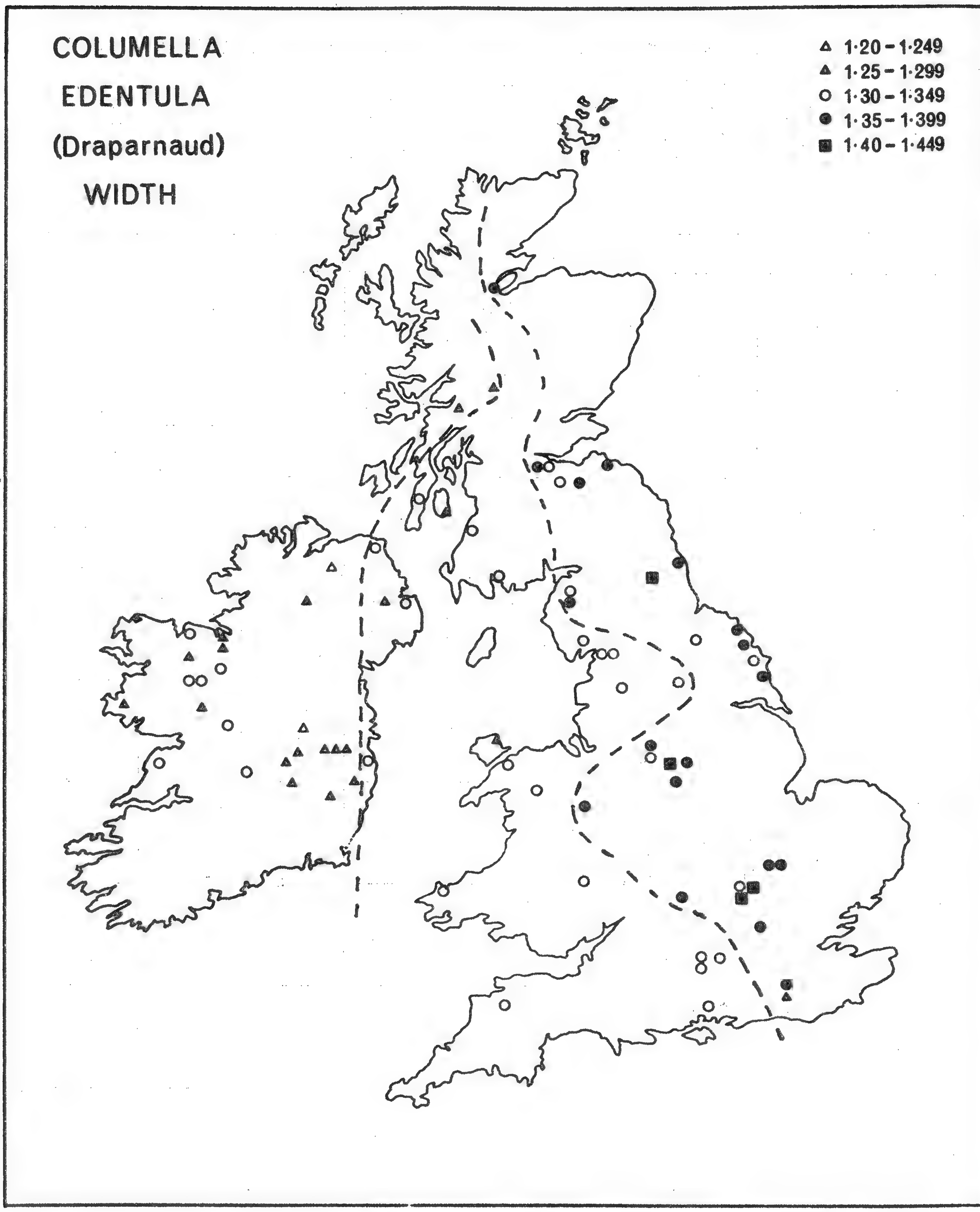

Fig. 5. Distribution map showing width trend for *C. edentula* (Draparnaud). Note that virtually all samples with mean widths greater than 1·35 mm lie in eastern Scotland and central and eastern England, while almost all samples with mean widths less than 1·30 mm lie in western Scotland, Anglesey and Ireland.

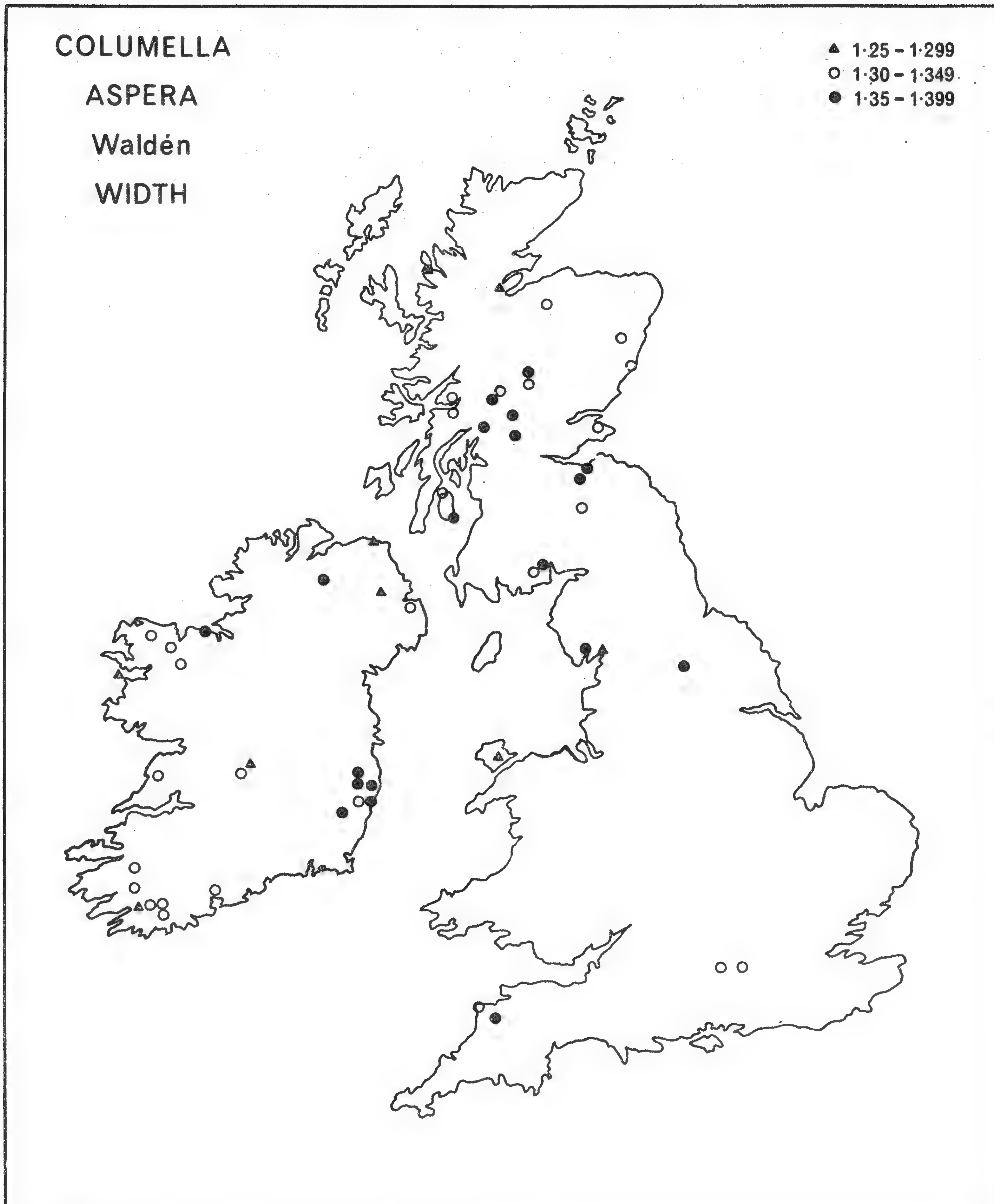

Fig. 6. Distribution map showing width in *C. aspera* Waldén. Note that no consistent trend is apparent.

VARIATION

Shell characters of all three *Columella* species vary to some degree. Since adult shells do not reach a definite maximum size, variation in dimensions might be expected to depend more on the maturity of a samples than upon specific differences. Nevertheless populations of each species show characteristic size ranges. Specimens of *C. aspera* over 2·0 mm long are unusual although the species may reach 2·6 mm in Britain. Mature *C. edentula* usually range in length from about 2·0 mm to 2·75 mm but may reach 3·3 mm. British fossil *C. columella* range from about 2·50 to 3·25 mm and Waldén (1966, p. 53) gives maximum sizes of recent European material as 2·95–3·06 mm. Great length alone will not distinguish *C. columella* from *C. edentula*; Waldén's figures indicate that the latter may exceed *C. columella* in length by as much as 0·64 mm. Waldén (1966, p. 52) also states that in colder conditions populations of *C. edentula* tend to become more elongate. *C. edentula* and *C. columella* can be distinguished in fossil populations on the basis of the apex which is larger and more hemispherical in *C. columella*. Both species frequently occur together, e.g. in late glacial samples from Castle Hill, Folkestone, Kent kindly loaned by Dr. Kerney.

Early in this study Dr. Waldén suggested that some Irish populations of *C. aspera* were unusually slender and resembled the American species *C. simplex* Gould. Consequently I measured width in both *C. aspera* and *C. edentula* from as many widely distributed localities as possible. To reduce bias introduced by young individuals, specimens of *C. aspera* less than 1·5 mm long, and of *C. edentula* less than 2·0 mm long, were rejected from all samples in which width was measured. Mean population widths for all samples of five or more mature shells were plotted on distribution maps (Figs. 5 and 6). For *C. edentula* this gave 45 samples from Great Britain with an average of 16·5 specimens per sample and 25 samples from Ireland with an average of 15·8 specimens per sample. The plots show that whereas variation in width is fairly random for *C. aspera* there is a consistent trend for *C. edentula* to become more slender westwards (Fig. 5). All mean widths greater than 1·350 mm lie to the east of the line through central England and central Scotland. All but three values less than 1·300 mm lie to the west of the line through eastern Ireland and the western Highlands of Scotland. Of these three unusually low mean widths, two are island populations (on Arran and Anglesey) with mean widths of 1·299 mm and the third is a more anomalous small sample of eight specimens from Ardingly, Sussex, with a mean width of 1·295 mm. Irish *C. edentula* are noticeably more slender than English populations, 15 of the 25 samples have mean widths less than 1·300 mm, and Fig. 1 attempts to illustrate this with actual shell outlines. The fact that this trend is fairly consistent and clearly apparent suggests that it is not an artifact of the small size of some samples. A plot of all samples with 10 or more specimens merely reduces the coverage somewhat but does not alter the general trend. The reasons for this trend are unknown. The most obvious suggestion is that it is related to climate in some way: high humidity in western regions producing slender shells. Precisely how humidity affects width is, of course, unknown and any such explana-

tion fails to take into acount the fact that the trend only affects *C. edentula* not *C. aspera.* I have been unable to detect any habitat differences between Irish and British *C. edentula* nor to detect any correlation between width and habitat in either region. Clearly more work needs to be done on the ecology of *Columella* in the British Isles.

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REVIEW

Marine Molluscan Genera of Western North America. By A. Myra Keen and Eugene Coan, Stanford University Press, Second Edition, 1974, 208 pp.

This is the second edition of a well known illustrated key to the genera of marine Mollusca found on the west coast of North America from the Arctic Circle to southern Baja California. There are considerable improvements over the first edition both in text and illustrations. The key refers only to genera with hard parts but a welcome addition is a systematic list of all the 590 genera which are recognized from the area. The most valuable new feature is a partial bibliography of original papers up to 1973 which enables species identification to be attempted.

It is ironical that there is no modern work which fully describes the mollusc fauna of this area. Dr. Keen's *Sea Shells of Tropical West America* deals with the Panamanian province to the south and far tropical waters have the greater appeal to many.

The key itself is very well written with few of the frustrating subjective kind of couplets

"Anterior canal relatively broad

Anterior canal relatively narrow"

which assume that both specimens are before one! The line drawings are clear and serve their purpose well. There is no key to higher taxa, and indeed it is pointed out that "molluscan taxa may be keyed out objectively at the generic level". For the Gastropoda this generates up to 262 couplets which may have to be worked through. I personally feel that an additional key to superfamilies such as is found in Tebble's *British Bivalve Seashells* produces an easier system to work. The majority of genera group into families in any case, though trouble comes with the shells of the pulmonate, opisthobranch and prosobranch limpets!

Genera without hard parts (other than radula) are not included in the key, but some opisthobranchs with greatly reduced internal shells are included. The lack of reference to 'soft parts' is not calculated to encourage shell collectors to look at the animals. *Chelidonura inermis* is illustrated as being about 90 mm in length (they do grow to 180 mm), but to show *Aglaja diomedia* as 40 mm in length seems out by an order of magnitude.

Needless to say, this work is invaluable, incorporating as it does many of the recent taxonomic advances. I hope it does not lull workers into a false sense of security, as there is an urgent need for a text on the marine molluscan species of western North America.

M. J. Bishop

J. Conch. *28*: 385–386 (1975)

REVIEW

American malacologists. A national register of professional and amateur malaccologists and private shell collectors and biographies of early American mollusk workers born between 1618 and 1900. Edited by R. Tucker Abbott (*et al.*). Pp. i–iv, 1–494. American Malacologists, 6314 Waterway Drive, Falls Church, Virginia 22044. Price $12.50.

This handy-size volume sets out to give potted biographies of malacologists and shell collectors who are, or were, active in North and South America at any time from the early seventeenth century up to 1973. Its principal purpose is to present information about men and women still living, the section on deceased workers being notably brief. Unquestionably the wealth of information on the living could have been condensed and that on the deceased enlarged to give a more balanced overall coverage. Constantine Samuel Rafinesque, one of the most colourful and prolific workers ever to grace the American malacological scene, is summarily disposed of in nine lines: dozens of modern hopefuls luxuriate in twice as many. Better to dispense with the oldies altogether rather than insult them. For each of the 1,000 or so living biographees there is a comprehensive listing of information including full names, birth date and place, citizenship, occupation, education, career, malacological memberships, writings, mollusc research areas, private collection particulars, travel for molluscs, honours, listings in other reference directtories, spouse, and home and office address. As this information was required from each of those who received an application form it is not surprising that less than a third of the recipients returned them. The education and subsequent career of an applicant makes up the bulk of each entry and doesn't leave much room for information on his writings and research which is the kind of information one would have thought the more desirable and useful. Is it really all that important where you went to school, what you did there and what you came out with? Is it really useful to know that someone is a food store clerk or that someone else is a singer who played the supper clubs in New York? The statistics are often very impressive. Some of the biographees seem to have collected colleges more than they have collected shells. Some seem to have picked up medals as easily as lesser mortals pick up colds; but why take up valuable space telling us so? Surely it would be much more helpful to have more information about what they do and less about what they got for doing it? Although such information is likely to be useful to someone somewhere it does seem as though the editors have overreached themselves and have almost lost sight of the most useful aspects of such a register. It is almost as if the information is meant for a historian of the future and not for the benefit of present-day students. Hopefully a future edition will incorporate more details of practical value, in particular those concerning work, travel, collections and specialities.

It is very satisfying to see entries about deceased workers who would otherwise have lapsed into undeserved obscurity. It is right that John H. Campbell should find a place here. He was after all first President of the American Association of Conchologists in 1892, and his large cowry collection is now at the Academy of Natural Sciences, Philadelphia. But for this register he, and others like him, could vanish without trace. On the other hand Andrew Carnegie, who is unlikely to be one of America's forgotten men yet awhile, could well do without a listing here merely on the strength of having a snail named after him. Similarly David Glasgow Farragut scarcely qualifies for inclusion on the strength of a subgenus of land snails being named *Farragutia* after him. The register also says that he uttered the words 'Damn the torpedoes! Go ahead.' a brave utterance no doubt, but in the present context, a supremely irrelevant one. To sum up, there is a lot of useful information in this book succinctly presented and clearly printed. It could do with some pruning here and there and could also do more justice to the dear departed, but it is certain to be indispensible in or out of the Americas.

S. Peter Dance

THE CONCHOLOGICAL SOCIETY OF GREAT BRITAIN AND IRELAND

INCOME AND EXPENDITURE ACCOUNT FOR THE YEAR ENDED 31st DECEMBER, 1974

	£	£
Publications:		
Newsletter		707·79
Student Papers		7·48
Journal:		
Volume 28 No. 2	614·50	
Volume 28 No. 3 (Estimated)	750·00	
Volume 28 No. 4	757·22	
		2,121·72
Sundry Expenses		70·35
Printing, Stationery and Postage		308·98
Officers' Expenses		125·55
Subscriptions		7·00
		£3,348·87

Fees and Subscriptions:		
Membership Fees	1,626·98	
Subscriptions	732·72	
Entrance Fees	23·50	
		2,383·20
Donations		24·75
Sales:		
Advertising	14·00	
Journals	53·52	
Students Papers	11·92	
Newsletter	5·31	
Sundries	15·70	
		100·45
Investment Income:		
General Account	466·16	
Life Members Fund	66·78	
Reserve and Research Fund	83·36	
	616·30	
Transfer to Reserve and Research Fund	83·36	
		532·94
Net Deficit		307·53
		£3,348·87

BALANCE SHEET AS AT 31st DECEMBER, 1974

	£	£
Reserve for Creditors		1,507·22
Fees and Subscriptions in Advance		322·12
Life Membership Fund... ...		850·00
Reserve and Research Fund ...		1,144·68
Capital Account		
Balance Bt./Fwd.	5,933·40	
Less Deficit	307·53	
		5,625·87
		£9,449·89

	£	£
Cash at Bank: Current Account ...	878·82	
Deposit Account ...	2,699·90	
Cash in Hand	6·77	
		3,585·49
Investments		
£400 5% Treasury Stock 1986/89 (£163·50)	344·00	
£500 $5\frac{3}{4}$% Deb. Stock Mersey Docks and Harbour Board 1976/78	460·85	
£737 $6\frac{3}{4}$% Stock Greater London Council 1976 (£660·21) ...	721·52	
2,514 Units M. & G. Dividend Fund (£985·49)	1,522·06	
£400 $5\frac{3}{8}$% Loan City of Norwich	400·00	
£800 $5\frac{1}{2}$% Loan London County Council	769·20	
1,620 Scotincome Units (£335·34)	892·95	
£875 Spillers 7% Deb. Stock 1978/83	753·82	
		5,864·40
		£9,449·89

W. F. Edwards }
C. W. Pettitt } Hon. Auditors.
22nd January 1975 J.E.C. 5·2·1975

Marjorie Fogan,
Hon. Treasurer.

J. Conch. *28*: 389–394 (1975)

PROCEEDINGS OF THE CONCHOLOGICAL SOCIETY OF GREAT BRITAIN AND IRELAND

TREASURER'S REPORT, 1974

It will be seen that for the year the Balance Sheet shows a deficit. This is misleading since, as pointed out in the 1973 Report, accounts for Vol. 28 No. 2 of the *Journal of Conchology* and for the December 1973 issue of the *Conchologists' Newsletter* were not received in time for inclusion in the 1973 accounts, and it is the carrying forward of these sums into the 1974 account which has overweighted the expenditure for this year.

Because of delay by the printers the accounts for both Vol. 28 No. 3 and No. 4 of the *Journal* were not received until after the end of this year, but to avoid perpetuating the carryover of expenses an estimated figure is shown in the Balance Sheet; this is actually slightly in excess of the true figure.

The income from Members' Subscriptions shows an increase on 1974, partly assisted by the inclusion of transitional relief on Covenanted Subscriptions for the two years, 1973 and 1974. The income from *Journal* Subscribers is comparable with that for 1972; the apparent decrease from the 1973 amount is due to the fact that in that year substantial orders for back nos. were received from some Subscribers.

The increase in the investment income owes something to the delay in receiving the printers' accounts, which allowed the retention of an unusually large balance in the deposit account. It has also been possible to increase the rate of interest on the City of Norwich Loan from $5\frac{3}{8}\%$ to $12\frac{3}{4}\%$.

Printing and postage as usual are responsible for most of the Society's expenditure, and considerable concern must be felt as to the effect of the forthcoming heavy increases in postal costs. Your Council is most anxious to make all possible economies and is exploring several possibilities, but the prospect of increases in some of the Society's charges in the near future cannot be ruled out. Members are asked to assist by prompt payment of subscriptions to avoid the expense of individual reminders, and are asked to note that publications cannot be sent to those whose subscriptions for the current year are unpaid. More payment by means of Seven Year Covenant would be appreciated, as these provide a most useful addition to income.

21 Members and 12 Junior Members are in arrears with 1974 Subscriptions and their names have been removed from the mailing lists.

Marjorie Fogan
Hon. Treasurer

REPORT OF THE COUNCIL 1974–75

Membership. It is with deep reget that the Society has to report the death of Arthur Blok, O.B.E., B.Sc., D.Sc., M.I.E.E. who joined the Society in 1924 and was made an Honorary Member in 1972. Total membership now stands at 585 and comprises the following categories:– Full Members 488, Family Members 30, Life Members 17, Honorary Members 2, Junior Members 48.

During the year 24 members resigned from the Society and a further 28 were removed from membership because of continued non-payment of subscriptions. These losses were balanced by the intake of 62 new members during the year thus maintaining an overall growth in membership.

Subscribers. During 1974 the number of subscribers rose slightly from 165 to 168. This number includes 12 cancellations and 15 new subscriptions. Subscriptions to the Conchologists' Newsletter and papers from students rose from 10 to 12.

Meetings. Seven ordinary meetings and one annual general meeting were held in the Conversazione Room at the British Museum (Natural History) as follows:– 16 March 1974: Lecture "Madeiran molluscs" by Mr. C. W. Pettitt. 20 April 1974: Conversazione Meeting. 18 May 1974: Lecture "Recent and fossil oysters"' by Mr. G. Osborn. 19 October 1974: Lecture "West American marine molluscs – some micro-habitats" by Dr. M. J. Bishop. 16 November 1974: Lecture "Gastropods of the East African coral reefs" by Mr. F. Pinn. 14 December 1974: Lecture "Research on Ponds" by Mr. J. F. Peake. 18 January 1975: Lecture "The cultured pearl" by Dr. E. E. Sandor, 22 February 1975: Annual General Meeting, Presidential Address "Investigating Feeding Habits in Land Snails".

Field Meetings. 6 Field meetings were held during 1974 as follows:– 5 May: Walton-on-the-Naze, Essex (joint meeting with the Bedfordshire and Northamptonshire Natural History Societies); 10–12 May: Gower Peninsula, S. Wales. 15 June: Leicestershire. 17 August: Dungeness, Kent. 20 October Luton, Bedfordshire. 17 November: Kew Gardens. Three field meetings were cancelled due to lack of support. One non-marine meeting was held by the Northwestern Conchological Group.

Thanks are due to the following for leading these meetings:– Dr. J. E. Chatfield, Dr. T. E. Thompson, Dr. A. Rundle, Mrs. C. J. Pain, and Messrs I. M. Evans and W. F. Edwards. An attendance of over a hundred at the Walton-on-the-Naze meeting was a record which is unlikely to be beaten.

Publications. Two parts of Journal of Conchology were issued, Vol. 28 parts 3 and 4. Quarterly "Conchologists' Newsletters", an annual membership list and a programme of meetings were also published.

RECORDER'S REPORT: NON-MARINE MOLLUSCA

A. 10-Kilometre Square Mapping

In spite of the cancellation of an intended expedition to Scotland in the summer, 1974 saw further excellent progress with the mapping scheme. To date, a total of nearly 110,000 post-1950 10-kilometre square records have been incorporated on the master-cards. More or less adequate species lists are available for over 90% of the grid squares in the British Isles, coverage for England and Wales being almost complete. During the past year I should particularly like to thank Dr. R. Anderson, who single-handed has systematically mapped about three-quarters of Northern Ireland.

All records accumulated to 31 December 1974 are now with the Biological Records Centre at Monks Wood for map-making, and it is hoped that a first edition of our *Atlas* will be printed in time for the centenary year of the Society (1976).

B. Vice-county Records

The following new records have been verified since the last Recorder's report (*J. Conch., Lond.* **28**: 257). Unless otherwise stated, the date of collection was 1974.

Channel Isles (0, or 113): *Segmentina nitida*, "Les Marais", Jersey, R. Rimmer, *circa* 1875 (Royal Scottish Museum).
Somerset South (5): *Agriolimax caruanae*, Nettlecombe (31/03), Miss S. M. Davies, 1973.
Isle of Wight (10): *Planorbarius corneus*, Newport (40/4989), R. C. Preece, 1967.
Kent East (15): *Agriolimax caruanae*, Hawkhurst (51/7631), Miss S. M. Davies.
Kent West (16): *Agriolimax caruanae*, Charlton (51/4178), A. J. Rundle, 1975.
Surrey (17): *Monacha cartusiana*, Sutton (51/26), R. P. Smith, 1910 (Royal Scottish Museum).
Middlesex (21): *Menetus dilatatus*, Grand Union Canal, Willesden (51/2182); *Agriolimax caruanae*, Kensal Green (51/2581), A. J. Rundle.
Suffolk East (25): *Pisidium pseudosphaerium*, Minsmere River Marsh (62/4467), M. J. Bishop.
Cambridge (29): *Vertigo substriata*, Buff Wood, East Hatley (52/2850), 1947, collector unknown; *Limax marginatus*, Hayley Wood (52/2953), C. R. C. Paul, 1966.
Hunts (31): *Planorbis laevis*, Grafham Water (52/1467), A. J. Rundle.
Pembroke (45): *Agriolimax caruanae*, Orielton (11/99), Miss S. M. Davies, 1972.
Anglesey (52): *Monacha cantiana*, Newborough Warren (23/4063), C. R. C. Paul.
Leicester (55): *Azeca goodalli*, Sheet Hedges Wood, Groby (43/5208), M. P. Kerney; *Pisidium moitessierianum*, R. Gwash, Empingham (43/9602), J. H. Mathias.
Derby (57): *Agriolimax caruanae*, Castleton (43/18), L. Lloyd-Evans, 1971.
York South-east (61): *Vertigo substriata*, Harpham (54/0861), A. Norris.
York North-east (62): *Agriolimax caruanae*, Stokesley (45/50), L. Lloyd-Evans, 1970.
Westmorland (69): *Arion lusitanicus*, Ambleside (35/3603; garden); *Agriolimax caruanae*, Windermere (34/4098), B. Colville, 1973).
Cumberland (70): *Agriolimax caruanae*, Kirklinton (35/46), M. P. Kerney, 1973.
Kirkcudbright (73): *Sphaerium lacustre*, Old Orchardton (25/8155), C. R. C. Paul.
Wigtown (74): *Hydrobia ulvae*, Torrs Warren (25/1755), C. R. C. Paul.
Lanark (77): *Arion lusitanicus*, Glasgow (26/5767; garden), Miss S. M. Davies.
Stirling (86): *Limax cinereoniger*, Ross Point (26/3796), 1973; *Agriolimax agrestis*, Pass of Balmaha (26/4191), H. W. Waldén, 1973.

Perth West (87): *Agriolimax agrestis*, Loch Lubnaig (27/5814), H. W. Waldén, 1973.
Forfar (90): *Helicella virgata*, Dundee (37/43), collector unknown, before 1900 (Royal Scottish Museum).
Kincardine (91): *Helix aspersa*, Long Slough (38/9602), E. Kellock.
Aberdeen South (92): *Potamopyrgus jenkinsi*, Peterculter (38/8204), E. Kellock.
Aberdeen North (93): *Planorbis laevis*, *Planorbis contortus*, Loch of Strathbeg (48/0758), M. R. Young.
Banff (94): *Milax gagates*, Portknockie (38/4868), E. Kellock.
Easterness (96): *Agriolimax caruanae*, Insh (28/80), Miss S. M. Davies.
Main Argyll (98): *Hydrobia neglecta*, Easdale, Isle of Seil (17/7617), T. Warwick, 1973; *Vallonia costata*, Sanna Bay (17/4469), R. A. D. Cameron.
Mid Ebudes (103): *Pupilla muscorum*, *Vallonia costata*, Tiree (17/0547); *Vertigo substriata*, coll (17/1657), R. A. D. Cameron, 1973.
North Ebudes (104): *Oxychilus helveticus*, Dunvegan Castle, Skye (18/2449), before 1867 (Hyndman/Thompson coll., Ulster Museum).
Sutherland East (107): *Phytia myosotis*, Dornoch (28/8088); *Hygromia striolata*, *Pisidium milium*, *Pisidium subtruncatum*, Dornoch (28/7989), R. G. Meiklejohn.
Sutherland West (108): *Acanthinula aculeata*, Loch Roe (29/0724), B. Colville.
Caithness (109): *Acroloxus lacustris*, Wick River (39/3451); *Helicella virgata*, Dunnet Bay (39/2168), R. G. Meiklejohn.
Outer Hebrides (110): *Hygromia subrufescens*, "Tarbert, Harris; or N. Uist", G. H. Harrison, 1938 (Royal Scottish Museum).
Zetland (112): *Leucophytia bidentata*, Out Skerries (68/6872), J. Darlington.
Cork West (H 3): *Arion lusitanicus*, Glengarriff (V 9057), M. J. Bishop, 1973.
Donegal East (H 34): *Agriolimax caruanae*, Buncrana (C 33), Miss S. M. Davies, 1971.
Tyrone (H 36): *Planorbarius corneus*, *Vertigo antivertigo*, *Pisidium pulchellum*, Brantry Lough (H 7553); *Segmentina complanata*, Lough Fadda (H 4448); *Arianta arbustorum*, Coagh (H 8977); *Oxychilus draparnaudi*, Lisdivin House (C 3704); *Agriolimax caruanae*, Castlecaulfield (H 7461); *Pisidium obtusale*, Cam Lough (H 6676), R. Anderson.
Derry (H 40): *Planorbarius corneus*, *Sphaerium lacustre*, Toome (H 9690); *Vitrina pyrenaica*, *Milax budapestensis*, Castleroe Wood, Coleraine (C 8629), R. Anderson.

The year has seen several interesting finds. *Vitrina pyrenaica* has been detected at another site in Ireland, by the R. Bann near Coleraine, Derry. Here it lives commonly in a variety of habitats "from wet river bank to mixed alder and Douglas fir wood" (Dr. Anderson). Many specimens were unusually large and darkly pigmented.

Dr. Rundle has found *Menetus dilatatus* (fresh empty shells) at several spots in the Grand Union Canal in London, the first records of this probably alien species for the south of England; *Sphaerium transversum* occurred in association. Another interesting freshwater find is *Acroloxus lacustris* in Caithness, considerably extending its known northerly range, *Pisidium pseudosphaerium* in Suffolk is also noteworthy.

Arion lusitanicus has occurred for the first time in Scotland, in a garden in Glasgow.

Among new vice-comital records based on museum material, two are of particular interest: *Oxychilus helveticus* from Dunvegan Castle, Skye (before 1867), a species rare in Scotland, old determinations being mostly wrong or suspect; and *Monacha cartusiana* from Sutton, Surrey (1910), which confirms an ancient record from "Banstead Downs" by Daniel Cooper (appendix to *Flora Metropolitana*, 1836). *M. cartusiana* seems now to be extinct along the North Downs in Surrey and West Kent.

M. P. Kerney

RECORDER'S REPORT: MARINE MOLLUSCA

Master lists are now available for the 37 Census Areas with coastline, areas 4, 8, and 40 (offshore) having as yet few records. There is also a list for Area 44. Much recording activity has taken place and emphasis has been on organization of existing records, searching the literature and compiling cards for 10km square and offshore stations. It is now becoming clear which parts of our coastline have always been neglected and which are in urgent need of revisits.

The Information Sheets written last year have been printed and circulated, further supplies being available.

It is gratifying to report five species new to the British List: *Parastophia folini* (Bucquoy, Dautzenberg & Dollfus), *Aplysia parvula* Guilding (see *J. Conch., Lond.* **28**: 329), *Hermea variopicta* (da Costa) (see *Proc. malac. Soc. Lond.* **41**: 185), *Trapania maculata* Haefelfinger, and *Crassostrea gigas* (Gmelin) deliberately introduced for commercial purposes. Two species first reported last year, *Polycera faeroensis* and *Favorinus blianus* (*J. Conch., Lond.* **28**: 186, 190) have been found to have wider distribution.

The New Voucher Collection has been established in the Royal Scottish Museum and specimens are welcome.

B. Records from the Areas

In the interests of brevity I have restricted the records to those new or of particular note. There are additionally over 200 records of species upgraded to *A* (live post-1950) or *B* (fresh dead post-1950) many of which have been recorded for the first time this century. The lay-out of the report follows that of 1974.

Shetland (1): The expeditions organized by the Institute of Terrestrial Ecology during 1974 visited approximately 140 stations and recorded 120 live species of marine mollusc plus a further 17 as dead shells only. Nearly 80 species were the first records this century, the more interesting being *Buccinum humphreysianum* of which two specimens were found at Skipadock on shell gravel at 16·5m (R. Earll, 15.8.1974) and *Devonia perrieri* one specimen found at Scatsta Voe in *Leptosynapta* (N. A. Holme, 4.4.1974). There are 15 new records (all *A*): *Lepidopleurus asellus*, not uncommon; *Barleeia unifasciata*, two specimens at Turri Ness in a *Laminaria* holdfast at 5m (R. Earll, 7.1974); *Littorina mariae*, not uncommon; *Littorina neglecta*, surprisingly found at 10m on *Laminaria* near Braewick (R. Earll, 11.7.1974); *Margarites olivaceus*, in *Laminaria* holdfasts at three localities; *Acteonia senestra*, one specimen found at Eswick on *Enteromorpha* (J. Darlington, 23.7.1974); *Adalaria proxima*, not uncommon; *Aeolidiella glauca*, one specimen at Out Skerries on the shore (R. Earll, 19.8.1974); *Elysia viridis*, several (J. Darlington, 23.7.1974); *Eubranchus farrani*, one specimen found at Usta Ness (R. Earll, 17.7.1974); *Pleurobranchus membranaceus*, unexpectedly far north, one specimen at East Ness in a *Laminaria* holdfast at 5m (R. Earll, 17.8.1974); *Thecacera pennigera*, also far to the north of its previously known range, at Braewick on *Laminaria* at 5m (R. Earll, 11.7.1974); *Leucophytia bidentata*, common at Out Skerries; *Musculus costulatus*, several specimens at Eswick in a Laminaria holdfast at 5m (R. Earll, 17.8.1974); and *Thracia villosiuscula*, not uncommon. Specimens of all these new species have been retained at the Royal Scottish Museum. The total number of species is now approximately 375 of which 130 are *A* records.

Sutherland (2): Most of this year's field work has been carried out by the Area Representative Mr. R. G. Meiklejohn together with Mr. D. Adamson of Thurso sub-aqua club. There are 9 new *A* records: *Tonicella rubra*, at Portskerra on an old anchor at 3m (D.A.); *Potamopyrgus jenkinsi*, very common indeed in the Thurso river (R.G.M., 27.4.1974); *Acanthodoris pilosa*, and *Aeolidia papillosa* on Scrabster beach (R.G.M., 27.4.1974); *Archidoris pseudoargus*, in Thurso Bay on a rock at 5m (D.A., 1.9.1974); *Cadlina laevis*, in Thurso Bay on *Laminaria* at 5m (D.A., 1.9.1974); *Onchidoris muricata*, not uncommon; *Acanthocardium echinatum*, in Thurso Bay on sand at 12m (D.A., 4.1974); *Laevicardium crassum*, in Loch Eriboll on muddy sand at 14m (D.A., 4.5.1974). Additionally dead shells of *Cingula cingillus*, *Diodora apertura*, *Chlamys furtiva*, *Tellina squalida* and *Thracia villosiuscula* have been recorded. A handful of species have been upgraded to *A*. The total number of species is now 160, of which 95 are *A*.

Orkney (3): The specimen of the Caribbean species *Tellina magna* found in 1947 (Rendall, 1956) has come to light, lodged in the Royal Scottish Museum. The total number of species is nearly 300 of which 106 are *A*.

Aberdeen (6): The only new record is one valve of *Nucula sulcata* obtained from offshore investigations in the South Forties.

Firth of Forth (7): Only one new *A* record has been achieved, *Lepidopleurus cancellatus*, one specimen dredged off the Isle of May (D. W. McKay, 1973). Dead shells of *Eulimella laevis* and *Modiolus phaseolinus* were taken at the same time. Seven species have been upgraded to *A*, mostly pyramidellids taken from *Laminaria* holdfasts at Low Water Mark. The third recorded example of *Aegires punctilucens* was found in a *Laminaria* holdfast at L.W.M. (S. M. Smith, 18.9.1974), and Mr. G. W. Pitchford reports from field notes *Phytia myosotis* in an old boot at Aberlady in 1959. A large specimen of *Ostrea edulis* taken live off Granton in 1948 has been traced, and advances the last known date for a live record by nearly 100 years. The total number of species is now 310 of which 131 are *A*.

Northumberland (9): New records are *Beringius turtoni* and *Volutopsius norvegicus* obtained by offshore dredging (D. W. McKay in early 1974). *Liomesus ovum* was taken at the same time. The total number of species found is 262 of which 182 are *A*.

Yorkshire (11): Mr. Norris reports that two field trips were organized by members of the Yorkshire Conchological Society and the Yorkshire Naturalists' Union during 1974. These were to Bridlington Bay and a weekend to Whitby and Robin Hood's Bay where a dredged sample and a sample provided by Robin Hood's Bay laboratory produced a number of interesting molluscs. Species

new this year are all of *B* or *C* status and include *Aclis minor, Calliostoma papillosum, Triphora perversa, Eulimella macandrei, Scaphander lignarius, Lima sulcata,* and *Nucula sulcata.* In addition 10 species have been upgraded to *A* and 10 more to *B* or *C* as the first records this century. The 19th Century popularity of this Area is shown by the records from Scarborough where each of the 10km squares show over 250 species. The total number of species is now 329 of which 92 are *A*.

East Channel (14): Mrs. Pain reports a strange shortage of records for an Area so near London. There are still some 10km squares with less than 10 *A* records. *Acanthodoris pilosa* was found by Dr. Joan Llewellyn Jones in a fisherman's bucket at Dungeness, 17.8.1974, and is the only new record. The total list of species is now 153.

Portland (16): Mr. D. R. Seaward has reported considerable progress with recording 10km squares, the Weymouth square being the first for which over 100 *A* status species have been found. Four new species have been recorded: *Acanthodoris stellifera,* at Lyme Regis (D.R.S., 8.2.1974); *Crimora papillata,* at Portland (B. E. Picton, 1.6.1974); *Eubranchus farrani,* at Weymouth (D.R.S., 13.11.1974); *Trapania maculata,* three specimens at West Bay, Isle of Portland on foliose polyzoa on vertical rock at 12m (B.E.P., 1.6.1974). The total number of species is now 327 of which 193 are *A*.

Channel Islands (17): Mr. Brehaut is combing the literature and trying to make sense of the very numerous old records, together with a personal upgrading of species to *A*. The total number of species is now 376 of which 157 are *A*.

Plymouth (18): Mrs. Turk is compiling a detailed inventory of records in literature, manuscript and from field work for this Area and Areas 19 and 20, over 3,000 entries having been made so far. Records gathered over several years by Bristol University Zoology Department have been made available to Mrs. Turk and upgradings of several species have resulted. Improved recording is resulting from the establishment of permanently marked transects in several localities to monitor environmental changes. New species include *Aplysia parvula,* found off the Manacles and Porthoustock (G. Brown, 11.1974); *Hermea variopicta,* a rare southern species at Thurlestone (Dr. E. C. Southward); *Favorinus blianus,* off Porthkerris (G.B.). The total number of species found in this exceptionally well recorded Area is 465, of which 218 are *A*.

Scilly Isles (19): Mr. C. R. Hayton and Miss H. Price have added the following new species; *Acanthodoris pilosa, Eubranchus farrani* and *Facelina auriculata* agg. The total number of species is 320 of which 90 are *A*.

North Cornwall (20): Miss P. J. Renwick has added a number of *A* records for this rather barren coast, and submitted most of her finds to the new Voucher Collection. These include *Acmaea virginea, Lacuna crassior, Rostanga rufescens, Musculus costulatus* and *Turtonia minuta* all from St. Ives Island. The total number of species is now 176 of which 54 are *A*.

Bristol Channel (21): Two specimens of *Aplysia parvula* (Watermouth Cove, A. Bebbington & G.H.B.), the first found in Britain (see *J. Conch., Lond.* **28**: 329).

Cardigan Bay (22): Mrs. A. M. Brockbank and Mrs. J. L. Charlish are putting records on cards by 10km square and have shown that this Area is much poorer in shells, and in collectors, than of yesteryear. The famous beach at Mochras has 226 species recorded but few of these date from after 1950. The total number of species is 275 of which 53 are *A*.

Solway (25): Miss M. Milne is still trying to persuade members of the Cumbrian Natural History societies to take an interest in marine molluscs. Publicity for the Maryport shore ("Looks Natural", B.B.C. T.V.) has brought forth some comment. *Tellina crassa* and *Venus casina* are additions to the basic list. Dr. A. Perkins has discovered the source colony of *Pharus legumen.* The total number of species now recorded stands at 104 and with more support the number of live species could be much improved from the present 25.

Clyde and Argyll (29): The Boy Scouts of Mull are starting recording by 10km square, much of this work is very necessary. The total number of species is 433, of which 165 are *A*.

Minch (30): Mr. S. Angus has been very active in the Outer Hebrides and is proposing to make a study of the marine molluscs of Lewis and Harris (Areas 30, and 32 in part and all of 31). New species are *Lamellaria latens,* at Loch Ailort on *Fucus* (S. M. Smith, 5.8.1974); and a dead shell of *Turbonilla fenestrata* at Arisaig (S.M.S., 11.8.1974). A goodly number of species have been upgraded to *A* status as the result of dredging, especially in deeper water. Miss A. Taylor has the following rare bivalves among others, upgrading lists of Jeffreys and Marshall: *Cuspidaria costellata, Cuspidaria cuspidata, Sphenia binghami* and *Tellina balaustina.* There are 376 species, of which 164 are *A*.

Lewis (31): Records for this Area have been submitted by Mr. S. Angus and Mr. D. W. McKay, the former dredging in shallow water in Loch Roag and the latter offshore, with the result that new records are numerous. Live new records are: *Acanthochitona crinitus,* one specimen from Breasclete (S.A., 8.9.1974); *Littorina neglecta,* from Little Bernera (S.A., 8.9.1974); *Natica pallida,* two specimens,

offshore (D.W.McK.); *Trivia arctica,* from Ardroil (S.A., 17.8.1971); and dead shells include *Alvania beani, Alvania zetlandica, Balcis devians, Lepeta caeca, Mangelia coarctata, Mangelia nebula, Natica montagui, Olivia tinei* (previously reported from the Hebrides but not localized, presumed outside 100 fathom line), *Patella aspera, Puncturella noachina, Rissoa rufilabrum, Rissoella globularis, Scissurella crispata, Thesbia nana, Eulimella macandrei, Menestho divisa, Odostomia eulimoides, Odostomia plicata, Philine aperta, Retusa umbilicata, Arca lactea* (further north than expected), *Arca pectunculoides, Astarte sulcata, Cardium ovale, Chlamys similis, Crenella decussata, Nucula nucleus, Tellina pygmaea, Thracia villosiuscula, Venus fasciata.* The total number of species now recorded is 183 of which 54 are *A.*

Uist (32): New records are all from Harris and have been submitted by Mr. S. Angus. They are all dead shells: *Capulus ungaricus, Clathrus clathrus, Anomia ephippium, Chlamys nivea, Chlamys tigerina, Gari fervensis, Modiolus phaseolinus, Lutraria angustior* and *Solecurtus scopula.* The total number of species is 178 of which 70 are *A.*

Galway Bay (36): Dr. B. F. Keegan is in the process of a benthic survey of Galway Bay and has established that many species live now in this area. Literature records are yet to be added. New records include *Parastrophia folini,* dead shells found in sand at Burren (G. Kroon, 1973); *Favorinus blianus Polycera faeroensis, Crassostrea gigas* and *Mercenaria mercenaria.* The total number of species is now 258 of which 244 are *A.*

S. M. Smith

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Note: individual Census records are cited only for species which are rare, local, or otherwise of special interest.

CORRECTIONS

Page

25 List of species: *Limax maximus* (L.), delete parentheses; for *Agriolimax circumscriptus* read *Arion circumscriptus*; for *Agriolimax silvaticus* read *Arion silvaticus*
119 line 8: for 'Plate I' read 'Plate III'
122 line 11 from foot: for *Caecilioides acicula* read ' "Woodland" species'
181 Fig. 3: A. for ×30 read ×4; B. for ×6 read ×1.6; C. for ×3 read approx. natural size; D. for ×8 read ×4; E. for ×6 read ×2
191 line 5: for '*J. Conch.*' read '*Proc. Malac. Soc.*'
216 bottom line: for 'Liring' read 'Living'
247 line 5 from foot: for *Sementina* read *Segmentina*
260 line 6 from foot: for 'Welsh' read 'west'
261 line 7 from foot: for '28: 41–42' read '27: 371–372'
line 7 & 6 from foot: for 'The records of *Charonia lampas* and *Rossia macrosoma* are of especial interest' read 'The record of *Charonia lampas* is of especial interest'
312–315, 319, 320, 322: in text-figures 4–10, for 'accessary' read 'accessory'
322 Explanation of text-figure 11, transpose 'I' and 'J'; line one from foot, for 'J' read 'I'

CONCHOLOGICAL SOCIETY OF GREAT BRITAIN AND IRELAND

Annual Subscriptions (£3) fell due on 1 January and Members who have not already done so are urged to remit to the Hon. Treasurer without further delay. Those whose subscriptions are in arrears by more than one year cannot expect to receive copies of the *Journal*. Please make sure that your remittance fully covers the subscription or the total amount due. No receipt will be sent for any subscription paid by cheque on a United Kingdom bank, unless specially requested. It is essential that cheques should be made payable to the *Conchological Society of Great Britain and Ireland* and not to the Treasurer by name.

Members are requested to notify the Hon. Secretary promptly of any change of address.

INSTRUCTIONS TO AUTHORS

Authors of papers submitted for publication in the *Journal of Conchology* are urged to pay careful attention to the following notes. Any author who has difficulty in complying with these requests, or has queries concerning manuscripts, should consult the Hon. Editor **before** submitting a manuscript.

1. Manuscripts should be sent to the Publications Committee, c/o Mr. T. Pain, 47 Reynolds House, Millbank, London, SW1P 4HP.

2. **Two** copies of all text and illustrations should be submitted. (A few years ago the entire copy for one issue of the *Journal* was lost in a mail robbery!). Authors are strongly recommended to retain a further copy for proof correction.

3. The text should be **fully revised,** typed **double spaced,** with wide margins (at least 1 inch), pages numbered consecutively and should conform in style to recent issues of the *Journal.* Titles should be concise and apposite, address(es) of author(s) should follow the title. Linear measures and weights should be metric and authorities for specific names should be given when first mentioned. Location of voucher material should be stated wherever possible.

4. Originals of text-figures should be $1\frac{1}{2}$–2 times the final size but should not exceed 25 by 36 cm. They should be drawn in Indian ink on clean ground, numbered consecutively, and referred to in the text as "Fig. 1" etc. Authors are strongly urged to construct text-figures so as to make full use of the page width and to submit a copy reduced to final (published) size wherever possible. Lettering should be legible and not less than 1 mm high after reduction.

5. Plates should only be used when essential and **must** not exceed 19·5 by 15 cm. They should utilise quality prints showing fine detail and moderate contrast. As far as possible prints on one plate should be matched for contrast and brightness. Authors are urged to make fullest use of plate space due to the high cost of printing plates. In the text the explanations of text-figures and plates should follow the references.

6. Tables should be concise, fit into the text and table headings should be self explanatory wherever possible. Tables are not printed 'boxed'.

7. All papers referred to in the text (including synonymy lists) should be listed alphabetically by author's surnames at the end of the text under "References". For books give author's name, initials, date, full title, pages, plates and place of publication.

e.g.

ELLIS, A. E. 1926. *British snails. A guide to the non-marine gastropoda of Great Britain and Ireland, Pliocene to Recent.* 275 pp., 14 pls., Oxford.

BROWN, P. and STRATTON, G. B. (Editors). 1965. *World list of scientific periodicals published in the years 1900–1950.* (4th Ed.) 3 vols. London.

For periodicals give full title of the article, title of the periodical abbreviated according to the World List (4th Ed.), volume number, page numbers and plates.

e.g.

WOODWARD, F. R. 1965. Monograph of the British Lower Tertiary Unionidae, with descriptions of three new species. *J. Conch., Lond.* **25:** 316–330, pls. 22–27.

GOULD, S. J. 1969. An evolutionary microcosm: Pleistocene and Recent history of the land snail *P.* (*Poecilozonites*) in Bermuda. *Bull. Mus. comp. Zool. Harv.* **138:** 407–532, 5 pls.

8. Authors may obtain copies of all papers (other than brief notes) at cost price if ordered from printers (address: Messrs. Willmer Brothers Ltd., 62-68 Chester Street, Birkenhead, England) when galley proofs are returned.